THE Petroleum Engineer

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VOLUME V NUMBER XIII

A MAGAZINE OF METHODS FOR OPERATING MEN

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Meetings

American Institute of Mining and Metallurgical Engineers, Petroleum Division, Fall Meeting—October 12 and 13, Mayo Hotel, Tulsa, Oklahoma.

•

American Gas Association, Convention and Exhibition—October 29, Atlantic City, New Jersey.

•

American Petroleum Institute, Fifteenth Annual Meeting—November 12, 13, 14 and 15, Dallas, Texas.

•

National Exposition of Power and Mechanical Engineering—December 3, 4, 5, 6, 7 and 8, Grand Central Palace, New York City.

•

Society of Automotive Engineers, Annual Dinner—January 7, New York City.

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C. Morris — *President-General Manager*
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The Course of Oil

By K. C. SCLATER

A Suggestion for the Future

Refinery control and operating agreements as adopted under the Code would be entirely unnecessary if government would discharge its duty of conserving the crude oil supply. Prefaced by a discussion of these and other premises, C. B. Ames of The Texas Corporation, in a recent address, offers to the industry a suggestion for the future. So pointed and constructive is his suggestion that it may well be pondered by oil men everywhere. It is given here in part:

"A plan should be developed for the effective conservation of our crude oil supply and this plan should be one squaring with the Constitution of the United States. This can be accomplished through the medium of a compact between the Federal Government and the principal oil-producing states.

"The chief value of the Code has been its effect upon production of crude oil. Any incidental benefit growing out of the other provisions has been more than offset by the disadvantages, and after all, the control of crude oil production is the beginning and the end of the duty of government regarding petroleum. There is one reason and only one sound reason why government should control crude oil production and that is the necessity of conserving this limited supply for the good of the people as a whole. The industry, no matter how skillful it may be, is unable to conserve the supply because of the nature and consequence of our legal theory of title. The surface owner has the right to drill for oil and reduce it to possession, notwithstanding the fact that the country does not need it and that when he does so he drains oil from his neighbor's land. A majority of the surface owners may prefer to preserve their oil for future use, but they are unable to do so unless every surface owner does likewise. As this rule of law prevents the industry from conserving the supply it is necessary for government to intervene.

"Our petroleum engineers tell us that under our wasteful methods of extraction enormous quantities of oil are left in the ground, and that we could more than double our ultimate production from a given pool by scientific methods of extraction. The intelligent units in the industry are unable to apply scientific methods because of our defective laws. Scientific methods of extraction can only be applied to a pool when it is treated as a unit, and yet we allow every surface owner to pursue his own methods, no matter how reckless or wasteful they may be. This is not conservation.

"As the law renders the intelligent producer helpless and as the law can only be amended by government, it is the duty of government to correct the law. For many years this destructive policy has continued. The evil has been known to the industry; it has been declared by the Federal Oil Conservation Board; it has been known to the states, but it has not been corrected * * *.

"* * * * As Congress cannot directly control production, a serious question exists as to whether it can do so indirectly by denying the privilege of interstate transportation to petroleum and its products lawfully produced under the laws of a state, even though in excess of a Federal allocation * * * *.

"On the other hand, it is settled by the decisions of the Supreme Court that a state can, in the exercise of its police power, limit production of crude oil to the reasonable market demand. Approximately 80 per cent of our crude oil is produced by California, Oklahoma, and Texas. If these three states could effectively agree upon a program it would go a long way toward solving the problem and, if in addition to them, Kansas, Louisiana, New Mexico, and Michigan were added, the problem would be completely solved.

"As far back as 1926, the Federal Oil Conservation Board * * * * suggested that an agreement be made among the principal oil-producing states to control their production in order to secure adequate conservation. It was recognized that no one state can regulate its production in utter disregard of other states, because no matter how effectively one state exercises control, if other states overproduce, price destruction results and the state which is restricting its output, while conserving its supply, is penalizing its own producers. Over a generation or two, this might not be objectionable but those producers who are in need of money to pay their debts will not consent to such a plan, nor will the state force it on them.

"The Constitution of the United States authorizes states to make agreements with each other, subject to the approval of Congress, and there are numerous interstate agreements or compacts. Thus, by pursuing strictly Constitutional methods, Congress, in coöperation with the legislatures of a few states, can discharge the duty which rests upon government of conserving our crude supply by means of an interstate compact. Under such a plan, a commission would naturally be set up, composed of representatives of the contracting states and of the Federal Government, which would be charged with the duty of formulating a program of conservation and each state would, within its own borders, enforce the program.

"Such a plan was presented to Congress by the Oil States Advisory Committee a few years ago and received a sympathetic hearing but failed of passage. The problem since has grown more acute. The situation is better understood and there are no insuperable difficulties preventing its accomplishment. The Congressional Committee now studying this problem has an opportunity of rendering a remarkable public service and it is hoped that it will be able to recommend a course of action which will conserve our oil supply and will, at the same time, be an enormous improvement upon the existing cumbersome Code under which the industry is now endeavoring to operate."

« « « HIGHLIGHTS IN OILDOM » » »

New Regulations for Collecting Oil Tax

New regulations for collection of Federal oil taxes and to assist the Federal oil administrator in enforcing the program for balancing crude supply and demand were announced simultaneously September 11 by Guy L. Helvering, commissioner of the Bureau of Internal Revenue, and Secretary Ickes, Federal oil administrator. The new regulations are more stringent than those previously existing. The tax is one-tenth of a cent a bbl. on crude, collected at the point of production, and one-tenth of a cent a bbl. on refinery processing, and gasoline produced from natural gasoline. The regulations are designed to prevent evasion of the tax and to assist Secretary Ickes in checking the production of "hot oil."

Failure to pay the taxes or the deliberate evasion of them will make the offender subject to severe penalties. Failure to file a return can be penalized by the addition of 25 per cent of the tax as an additional payment, and a penalty of 50 per cent of the tax is provided for making false or fraudulent returns. Any person making a false affidavit or any other fraudulent representation in connection with the taxes also becomes liable to a maximum fine of $10,000 or imprisonment for not more than ten years.

Records of all persons required to pay the tax must be accessible for inspection by agents of the Federal Government or the state governments engaged in regulating the production of oil, as well as agents of the Bureau of Internal Revenue.

For hindering or obstructing officers of the Bureau of Internal Revenue while in the course of their duties a fine of $500 is provided. The latter officials also are given broad powers to inspect properties with the right to gauge and examine pipe line connections.

The regulations provide in detail for the type of records that must be kept by producers, purchasers, refiners and transporters. Producers and purchasers are required to make a $500 bond and upon failure to do so are subject to a fine of $1,000.

●

Gas Wastage a Live Topic

Gas pipe line company officials are renewing their efforts to cope with the problem of gas wastage in the Texas Panhandle and other fields. A committee composed of engineers appeared before the State Senate investigating committee on September 6 and presented a detailed report. The wastage, according to the report, is caused by stripping plants that remove the natural gasoline from the gas and blow the residue into the air. This practice is permitted by state law and has long been a matter of concern. As a solution to the problem the committee presented a plan for restoring the gas to the ground after it has been stripped. More than 1,000,000,000 cu. ft. of gas is being wasted daily in the Texas Panhandle alone under the existing practice, it was pointed out. Destruction of this gas field, the largest in the world, is inevitable within a short time at the present rate of wastage, the report stated.

With the same end in view, a group of executives of the major gas pipe line and natural gas companies met in Dallas on September 11. The day was spent in study and discussion of the report on gas wastage and conservation methods prepared by the engineering committee. It was decided that a later meeting should be called, at which time a conservation program will be considered.

●

Refiners Win Oil Tender Cases

Temporary injunctions obtained recently by the Texas Railroad Commission against approximately 30 East Texas refiners, restraining them from violating the tender order of August 29, have been set aside by District Judge E. M. Dodson of Marlin in the Travis County District Court. The ruling was based on the grounds that the State Legislature had not conferred power on the commission to regulate refined products. Attorneys for the state argued that regulation of movement of refined products, insofar as requirements of tenders was concerned, bore a reasonable relation to conservation of oil and gas, which has been authorized by the legislature. With this contention the court did not concur.

The commission's order of August 29 stipulated that tenders be furnished on every barrel of processed crude moved from the East Texas field, and transporters were forbidden to accept for transportation any oil not so approved. Before the order was made public, injunctions were obtained against all refineries that had attacked the previous orders covering the subject, and the four railroads serving East Texas were enjoined from accepting any oil that did not carry with it the tenders as provided.

Assistant Attorney General A. R. Stout said the state would take the case to the Third Court of Civil Appeals immediately, and, if necessary, it ultimately would reach the the Supreme Court.

●

Tighten Oil Shipment Regulations

The Federal Oil Administration has promulgated more stringent regulations governing shipments of petroleum products, aimed at the movement of "hot oil" from the East Texas field.

The administration has ordered that all shipments from East Texas into interstate commerce must be accompanied by an affidavit from the shipper to the carrier that the products were manufactured from legally produced crude oil. This was done by revising form O.E.S.-6, covering interstate shipments of petroleum products from East Texas. The revised regulation went into effect September 8.

Carriers accepting shipments without the affidavit are liable to a fine of $500 or six months in jail, or both, for each offense, and shippers can receive a maximum penalty of $10,000 fine and ten years' imprisonment for making false affidavits.

The original regulation, promulgated in July, did not provide for the affidavits because it was thought state regulations would suffice, particularly in Texas, it was pointed out by the oil administration in making the announcement of the revised form. However, it was found that shippers were evading the state regulations by shipping only in interstate commerce.

See What Others Are Doing with this Versatile Power

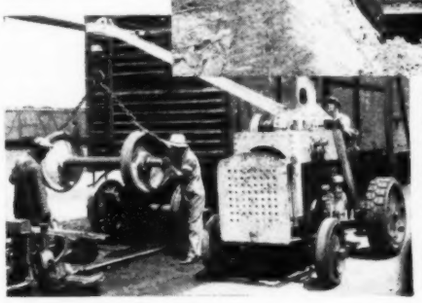
Above: The new McCormick-Deering Model I-12 industrial tractor, maneuvering a giant of the air at a municipal airport. This compact tractor offers speeds of from 2½ to 10¼ m. p. h., and ample power for airport, park, estate, and golf course (Fairway 12) requirements.

Backed by the **WORLD'S LARGEST TRACTOR BUILDER** *and a Country-wide Network of* **McCORMICK-DEERING SERVICE**

Above: The T-20 TracTracTor in a logging operation. The round hand-hole plates visible at the rear are a feature of TracTracTor accessibility.

Above: The Model I-12 industrial tractor hauling a train of lumber dollies. Here is efficient power for railroads, lumber yards, woodworking shops, etc.

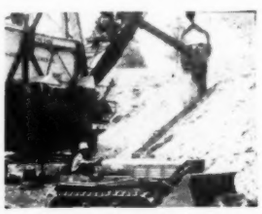
Above: A leading brewery moves freight cars and performs many other tasks with this powerful Model I-30 industrial tractor.



Above: The McCormick-Deering Model T-40 TracTracTor at work on a dirt road job. This big crawler provides ideal power for road building and maintenance work, including snow removal.

At Left: A railway company uses this crane-equipped Model I-30 industrial tractor in maintenance work.

Above: A 25 h. p. power unit installation in the oil country. This efficient engine operates on natural gas and pumps three wells simultaneously.



Above: This T-40 TracTracTor and bull-dozer outfit helps to operate a strip coal mine profitably. Built with 6-cylinder gasoline engine and 4-cylinder Diesel engine.

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McCormick-Deering Power is available in the form of power units, wheel tractors, crawler tractors, and modifications of these types.

Above: A 35 h. p. power unit operating a saw mill. Hundreds of outfits like this are at work, with good records to their credit.

Above: A McCormick-Deering-powered locomotive . . . an ideal unit for use in mine, quarry, clay pit, sand and gravel pit, etc.

Above: A 52 h. p. Diesel power unit operating a big gravel plant at remarkably low cost.

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At Left: The radio-controlled tractor featured in the International Harvester exhibit at the World's Fair, Chicago, performing before the news-reel camera. The compact design and short-turning radius of the "12" series tractors are emphasized in this driverless demonstration.

McCORMICK-DEERING INDUSTRIAL POWER

LATEST ACTIVITIES IN THE OIL FIELDS

RUSSELL County, Kansas, scene of the first oil discovery in western Kansas, has a new pool. H. H. Blair, Willis Hartman, and the Lario Oil and Gas Company brought in No. 1 Neidenthal, in the northeast corner of 23-14-15w, recently, the well making 707 bbl. of oil on its initial 24-hour test. Production is coming from the siliceous lime at a total depth of 3245 ft., only one ft. in the pay.

●

Frank Hollow of Wichita, discoverer of the Hollow pool, is believed to have found a new producing area in Harvey County, western Kansas. His No. 1 Somersfelt, a semi-wildcat test, has found oil in the Hunton lime at slightly below 3300 feet. The test is near the town of Hesston.

●

In wildcat territory near Stockton, Rooks County, Kansas, Pat Ashby and T. Seely's No. 1 Doughty topped the Oswald lime at 3186 ft. and was drilled to a total depth of 3225 feet. It was bailed at the rate of 10 to 12 bbl. per hour while awaiting a state production test.

●

The opening of a new pool in southwest Texas, eight miles from the closest production in the Pettus field, is holding the interest of oil men. The Mid-Continent Crude Oil Purchasing Company's No. 1 A. J. Kimball, in Bee County, was completed for an estimated 5000-bbl. well in the Pettus sand at a depth of 3543 feet.

●

Discovery of a new producing field in Live Oak County, Texas, stands out as possibly the most important development of the year for that part of the state. The Lion Oil & Refining Company's No. 1 McNeil, a rank wildcat, just northwest of the old Lucas gas field, topped the Hockley sand at a depth of 4370 ft. and was drilled to a total depth of 4376 feet. On the initial test the well flowed at the rate of ten bbl. of oil an hour through a ¼-in. choke.

●

Active interest in the Fitts area, southeastern Pontotoc County, Oklahoma, has continued and recently was increased by the extension of the gusher area of that pool. Ed H. Moore et al's No. 2 Wirick was brought in for a production of 297 bbl. in 24 hours through a 9/32-in. choke. The well is drilled to a total depth of 3997 ft. and is located a half mile east and two locations south of Crosbie et al's No. 1 Hardin and almost a mile due east of J. C. Shaffer, Inc., et al's No. 1 Hardin, both of which are gushers.

●

The Carter Oil Company's No. 1 Dill, a wildcat test 4½ miles north of production in the Cromwell pool, and 6½ miles west of Okemah in western Okfuskee County, Oklahoma, may prove to be of considerable importance. The well was drilled to a total depth of 3408 ft. in the Cromwell sand and produced 537 bbl. in 24 hours on the initial test.

●

New completions in the Cooper pool of Lea County, New Mexico, indicate the field is an extensive one. A recent completion, Humble Oil and Refining Company's No. 1 S. R. Cooper, extends the field a half mile northeast. Production was from lime formation at a total depth of 3562 ft. and at the rate of 30 bbl. of oil an hour accompanied by 100,000 cu. ft. of gas daily. This well eventually will necessitate the drilling of approximately 15 offset wells because of the irregular boundaries of the leases surrounding the location.

●

The Mirando district, Zapata County, Texas, has a new shallow pool. Merle Gunby et al's well No. 1 Alice D. Haynes was completed at a total depth of 841 ft. with production of approximately 35 bbl. daily of low gravity crude.

●

The Rodessa gas field of Caddo parish, Louisiana, was extended into Cass County, Texas, by the completion of a gasser a quarter of a mile west of the previous producing limits of the field. The new well, drilled to a total depth of 5875 ft., is the deepest of the 15 gassers in the area. The well gauged 55,312,000 cu. ft. of gas daily. It is Cass County's first commercial well.

AVERAGE CRUDE OIL PRICES

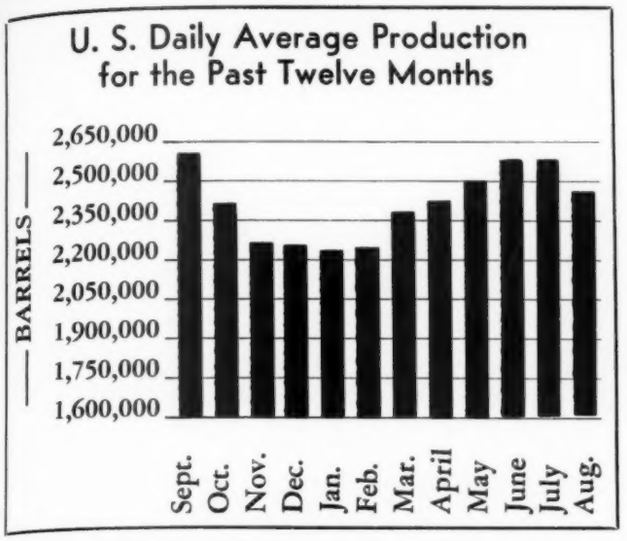
California	
Playa Del Rey	$ .90
Coalinga	.81
Signal Hill	1.12
Montana	1.35
Wyoming	1.00
Colorado	1.00
New Mexico	.75
Texas	
North Central	.95
Panhandle	.83
West Texas	.70-.75
Gulf Coast	1.04
Darst Creek	.87
East Texas	1.00
Kansas	1.00
Oklahoma	1.00
Arkansas	.70
Louisiana	
North Louisiana	$ .95
Gulf Coast	1.04
Illinois	1.12
Kentucky	1.17
Indiana	1.12
Ohio	
Lima	1.30
Michigan	1.02
Pennsylvania	
Bradford	2.55
Southwest	2.22
Eureka	2.17
Buckeye	2.07
West Virginia	2.07
Canada	2.10

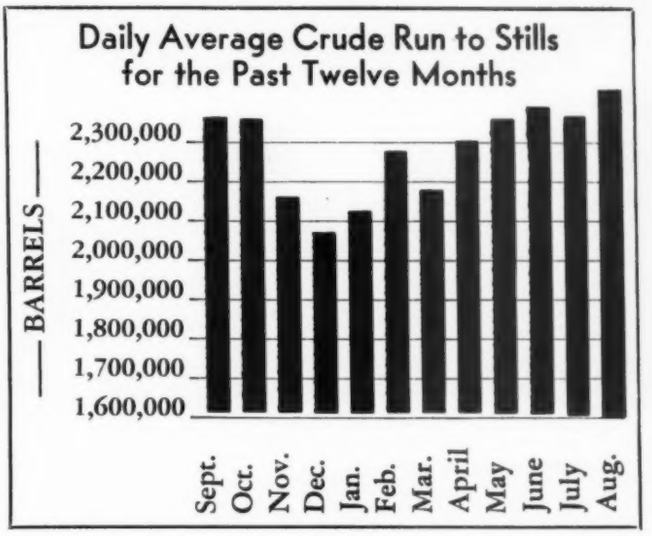
DAILY AVERAGE CRUDE OIL PRODUCTION

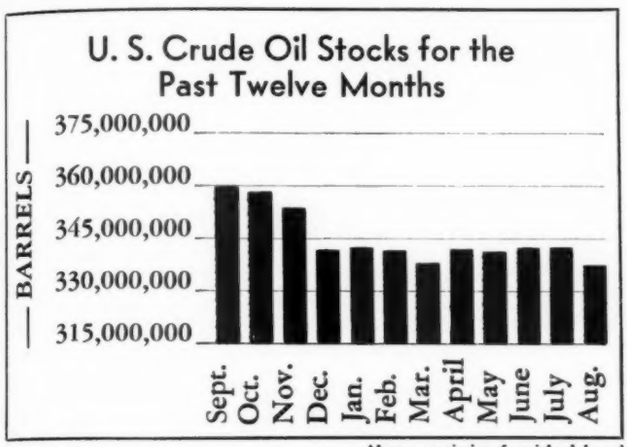
(Figures in barrels)

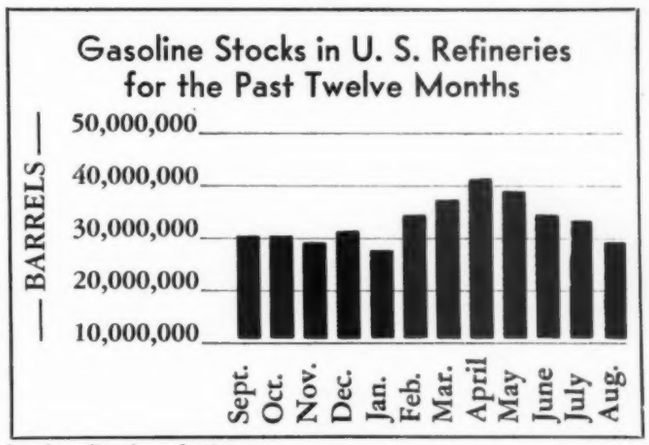
Furnished by A.P.I.

	Federal Agency Allowable Effective Aug. 1	Week Ended Sept. 1, 1934	Week Ended July 28, 1934	Week Ended Sept. 2, 1933
Oklahoma	480,100	460,550	491,750	548,150
Kansas	131,200	128,000	136,750	129,500
Panhandle Texas		59,800	62,750	49,300
North Texas		60,950	58,700	53,250
West Central Texas		27,100	27,100	21,900
West Texas		154,850	147,900	161,750
East Central Texas		51,800	51,550	58,450
East Texas		414,850	468,650	609,450
Conroe		47,650	47,300	91,800
Southwest Texas		57,400	56,250	51,800
Coastal Texas (Not incl. Conroe)		130,000	123,100	131,300
TOTAL TEXAS	1,001,300	1,004,400	1,043,300	1,229,000
North Louisiana		24,500	24,550	26,750
Coastal Louisiana		73,700	73,600	47,000
TOTAL LOUISIANA	87,200	98,200	98,150	73,750
Arkansas	30,400	31,450	32,050	31,350
Eastern (Not incl. Michigan)	102,200	108,200	100,000	99,050
Michigan	33,200	30,600	30,100	31,000
Wyoming	35,000	38,450	37,250	28,850
Montana	8,800	10,350	8,900	6,800
Colorado	3,000	3,700	3,400	2,400
TOTAL RK. MT. ST.	46,800	52,500	49,550	38,050
New Mexico	46,700	47,850	47,400	41,350
California	490,200	460,400	518,300	500,200
TOTAL U. S.	2,449,300	2,422,150	2,547,350	2,721,400









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for August, 1934

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	281	280	51	279	3600	2	40	Rotary
Duval County	21	16	3	12	2300	2	22	Rotary
Archer County	51	32	24	47	660–1800	1 or 2	40	Rot.-Cab.
Conroe	14	14	1	13	3000–7400	3 or 4	40	Rotary
Refugio County	10	10	3	19	5200	2	38	Rotary
Oklahoma								
Osage County	24	19	23	53	380–2850	2	37.5-40	Rot.-Cab.
Oklahoma City	8	7	8	24	6500	3	39	Rotary
Kansas								
Harvey County	9	9	2	11	3450	2 or 4	37	Rot.-Cab.
McPherson	17	15	6	26	2900–4300	2	38	Rot.-Cab.
Ellsworth Arch	24	22	16	73	3300	4	37	Cable
California								
Kettleman Hills	5	5	3	28	8300	3 or 4	40	Rotary
Long Beach	3	3	4	17	7000	3	26	Rotary

Field Activities by States for August, 1934

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1933 (In Barrels)
	August	July	August	July	August	July	August	July	August	July	
Arkansas	10	10	2	5	8	6	8	10	33	37	11,682,100
California	30	24	26	21	38	50	48	46	215	211	173,126,800
Colorado	1	2	0	1	....	....	3	4	33	34	954,900
Illinois	5	2	1	1	....	....	2	6	12	5	4,250,000
Indiana	12	14	6	8	....	....	2	2	42	36	730,000
Kansas	91	99	68	65	72	67	28	34	156	168	41,927,700
Kentucky	39	17	32	15	....	....	3	3	35	39	4,610,000
Louisiana	68	70	41	35	65	62	52	51	181	173	24,487,800
Michigan	39	51	29	33	38	39	111	89	135	132	7,790,800
Mississippi	3	3	0	1	....	....	5	3	13	12	Gas Prod.
Montana	18	22	13	19	....	....	10	11	62	61	2,128,700
New Mexico	13	10	9	9	....	....	17	15	64	62	13,086,600
New York	....	....	....	....	....	....	2	1	9	6	3,150,000
Ohio	128	50	100	36	....	....	51	41	207	195	4,300,000
Oklahoma	184	165	112	109	131	133	81	97	356	398	181,133,200
Pennsylvania	21	35	16	30	....	....	34	36	117	114	12,690,000
Texas	763	857	616	649	483	940	235	319	909	1140	396,993,600
West Virginia	17	10	13	9	....	....	40	35	77	67	3,825,000
Wyoming	4	6	4	4	....	....	13	12	66	68	11,211,000
Total	1446	1446	1088	1049	835	1297	745	823	2722	3076	898,078,200

PROGRESS OF MAJOR PIPE LINE WORK

THE first major California pipe line project in several years has been announced by the Standard Oil Company of California. Plans have been completed by that company for the laying of 108 miles of 12-in. welded pipe from producing fields in the San Joaquin Valley to connect with the Standard's marine terminal at Estero Bay in San Luis Obispo County. The line will start at the company's Rio Bravo pump station in Kern County and form a junction at a point in the Cholame Valley with existing facilities that run from the Kettleman Hills field to Estero Bay. From this junction the line will follow the present right-of-way to tidewater at Estero. The project is expected to cost approximately $4,000,000.

The line is being designed to transport both light and heavy oils. Five new pump stations will be constructed and some change will be made in the present facilities at Rio Bravo and Kern River.

Work is to commence immediately and officials of the Standard Oil Company of California estimate approximately seven months will be required to complete the project. The line will have a capacity of 60,000 bbl. daily. At Estero Bay the oil will be loaded into tankers for movement to the company's refineries and elsewhere.

●

The Sun Oil Company is planning an extension to its gasoline pipe line system in the East, construction work to begin in the spring. A 100-mile extension to the present line will be built from Malvern, Pennsylvania, across the Delaware River into New Jersey, thence across New Jersey northeast to a point on the seaboard, as yet undetermined. The Middlesex Pipe Line Company has been incorporated in New Jersey as a subsidiary of the Sun Oil Company to build and operate the new 6-in. line.

The Sun's existing system starts at the Marcus Hook, Pa., refinery of the company. An 8-in. line runs to Icedale, Pa., where it branches to the north and west. The western line runs west and north to Pittsburgh and Cleveland, and the northern branch to Syracuse, New York. Both are 6-in. lines.

●

Frank L. Chase, vice-president and manager of the Lone Star Gas Company, Dallas, Texas, announces that his company will construct a 75-mile gas line from the Long Lake field in southwestern Anderson County, Texas, to tie in with the Lone Star's line at Riesel, east of Waco. The survey is being made now and laying of the line will commence shortly. It is expected that the project will be completed by December 1, at a cost of approximately $900,000. The line will be of 12-in. welded construction. The pipe will come from an unused line in the company's Oklahoma system.

The new line will be used to supply gas to central Texas cities and towns. Gas supply will be from a field developed by the Texas Seaboard Oil Company of Dallas and the Tide Water Oil Company. Completions at this time include three dry gassers and two wells making gas with some distillate and oil. The wells are credited with 50,000,000 to 75,000,000 cu. ft. of gas daily from the Woodbine sand around 5200 feet. Since closed in rock pressure is approximately 2100 lb., no booster stations will be required to get the gas under pressure to the junction near Waco.

●

During the summer the Cities Service Gas Company has done considerable repair work on its trunk lines, consisting largely of replacing sections of old pipe with new. On the Leavenworth-Atchison, Kansas, line, which supplies not only these two cities, but St. Joseph, Missouri, as well, and on the line extending north from Atchison to Horton, Holton, Hiawatha and Sabetha, Kansas, and Falls City, Nebraska, two sections of pipe were renewed. One was 600 ft. in length and one 40 feet. In addition two new gate valves were installed. The new sections were of 16-in. welded pipe.

On the same line, north of Tonganoxie, Kansas, one-half mile of old pipe was replaced. Some time previously two ravine crossings were relaid on this line, north of Leavenworth, each crossing requiring approximately 20 ft. of pipe.

During the latter part of July, Cities Service replaced several sections of the old 16-in. Quapaw line west of Miami, Oklahoma. This line extends northeast from the Cotton Valley compressor station, north of Bartlesville, Oklahoma, supplying Miami, Oklahoma, and Springfield, Missouri. The company this summer also has replaced pipe along the southern trunk of the old Kansas Natural line that supplies Pittsburg and Girard, Kansas, as well as renewing portions of the 10-in. lateral running into these cities.

●

Henry P. Rothwell, one of the principal owners of the Padlock Livestock Company, on which company's ranch several gas wells have been brought in while drilling for water, has filed application with the Wyoming Public Service Commission for a certificate of public convenience and necessity for the construction and operation of a natural gas system for Gillette, Wyoming. Rothwell plans to lay a 25-mile pipe line from the Padlock ranch to Gillette.

A flow of gas estimated at from 500,000 to 1,500,000 cu. ft. was encountered at 300 ft. recently in a water well drilling on the Padlock ranch. Previously two wells drilled on the ranch had commercial flows of gas at shallow depths.

In his application to the Public Service Commission Rothwell stated that it was his intention to assign the permit, when granted, to a corporation for the purpose of constructing and operating the gas supply and distribution system. He further stated that construction of the system would begin within seven months from the date of the application with the work completed within one year.

●

The 30-mile pipe line of the Toronto Pipe Line Company (subsidiary of the British American Oil Company) from the Cut Bank field of Montana to Coutts, Alberta, Canada, has been completed and is running crude. The 6-in. line was laid by the contracting firm of Ford, Bacon and Davis, Inc., New York City, at a total cost of approximately $300,000. Included in the system is 12 miles of 4-in. gathering line through the Cut Bank field, and a tank farm and pump station on the Seeba lease in the center of the field.

The new line is being used for the transportation of crude oil from Cut Bank to the British American Oil Company's refineries at Coutts, Alberta, and Moose Jaw, Saskatchewan.

●

A marine petroleum terminal covering 45 acres and located on the Chelsea River in the Boston, Massachusetts, harbor, will be built by the Tide Water Oil Company, Edward L. Shea, president, has announced. Immediate construction plans call for the erection of eight tanks with a total capacity of 21,500,000 gal. for the storage of gasoline, range oil, fuel oils, lubricating oils and greases. Warehouses, garages, loading facilities and a dock for the mooring of the Tide Water marine fleet of ocean-going and coastwise vessels and barges will be built at this time. Ultimately it is planned to erect sufficient tankage for the storing of 43,000,000 gal. of products. The entire project is expected to be completed by January 1, 1935.

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 81.9 Per Cent **Central Division, 71.8 Per Cent** **Western Division, 61.7 Per Cent**

A NEW UNIT is being added to the road oil and asphalt plant of the M. M. McCallem Refining Company in the Huntington Beach field of California. The new unit will increase the capacity of the plant from 150 bbl. to approximately 250 bbl. daily.

●

Recent reports are to the effect that the Mexican government has approved the financing and construction of a large refinery near Mexico City to operate entirely upon Mexican crude. The plant is to be financed by funds subscribed only by Mexican citizens and the capital stock will be $5,000,000 it is reported. No official announcement has been made of the project, however, and in some quarters it is thought this may possibly be a political move on the part of the present government to placate popular opinion in the event it is decided to take drastic measures in restricting foreign organizations in Mexican petroleum activities.

●

Capacity of the McColl-Frontenac Oil Company's refinery at Montreal, Canada, has been increased from 5000 bbl. to 12,500 bbl. daily by the addition of two new cracking units. These units were recently completed after being under construction for a period of six months. The McColl-Frontenac Oil Company's total refining capacity (including that of the Toronto plant) is now 17,500 bbl. daily.

●

A two-unit casinghead gasoline plant has been completed and placed in operation at Weleetka, Oklahoma. The plant has a daily capacity of 5000 gal. and is owned by J. D. McQuillan of Okemah, Oklahoma, who is in active charge of operations.

●

The Lomita Gasoline Company's new natural gasoline plant in the Mountain View field of Kern County, California, was completed recently and is now in operation. Construction work was in charge of F. H. Garbutt and the plant was designed by J. A. Campbell.

●

The Gulf Production Company has sold its three-unit natural gasoline plant at Breckenridge, Texas, to the Lone Star Gas Company. The plant, with a capacity of 5000 gal. daily, has been closed down by the Lone Star.

●

A new 2000-bbl. unit has been added to the Mohawk Oil Company's refinery at Fruitvale, California. Successful development work by the Mohawk Oil Company in the Mountain View field brought about the enlargement of the plant.

●

The McMurrey Refining Company, Arp, Texas, has purchased the cracking plant of the Kettle Creek Refining Company of El Dorado, Arkansas, which will be dismantled and shipped to the Arp plant for reassembling. Approximately 20 cars will be required to transport the material, it is estimated. The cracking unit is expected to be in operation by November 15.

●

The Hartol Terminal Corporation, subsidiary of the Hartol Oil Products Corporation, will build and operate an ocean oil terminal at Revere, Massachusetts, it has been announced. The terminal will include storage tanks having a capacity of 235,000 bbl. and will cost approximately $500,000 to construct. It is planned for the work to be completed and the terminal in operation by October 10. Henry D. Vanderwyk will be in charge.

●

The plant of the Corpus Christi Refining Company at Corpus Christi, Texas, has been completed and placed in operation. From 1000 to 1500 bbl. of crude from near-by Texas fields is processed daily. G. L. Rowsey heads the company.

●

The Barnsdall Refining Company is constructing a special production plant at Avant, Oklahoma.

●

Cushing Oil and Refining Company, Cushing, Oklahoma, is constructing a vapor recovery plant in connection with its new cracking unit. The plant is of vapor rectification type patented and designed by Petroleum Engineering, Inc , Tulsa, Oklahoma.

●

The Hanlon-Buchanan Gasoline Company is adding a 54-in. 36-in. tray stabilizing unit to its recently completed plant at Gladewater, Texas.

●

The McClanahan Refining Company has been organized at Mt. Pleasant, Michigan, by Walter L. McClanahan, president of the McClanahan Oil Company, and a plant of 1000 to 1500 bbl. daily capacity will be erected. The location probably will be at Wheeler, ten miles south of the Porter Pool.

●

The Sunray Oil Company is constructing a 24,000,000-cu. ft. natural gasoline plant at Sunray, Texas. Petroleum Engineering, Inc., Tulsa, Oklahoma, is furnishing the design and equipment.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks,

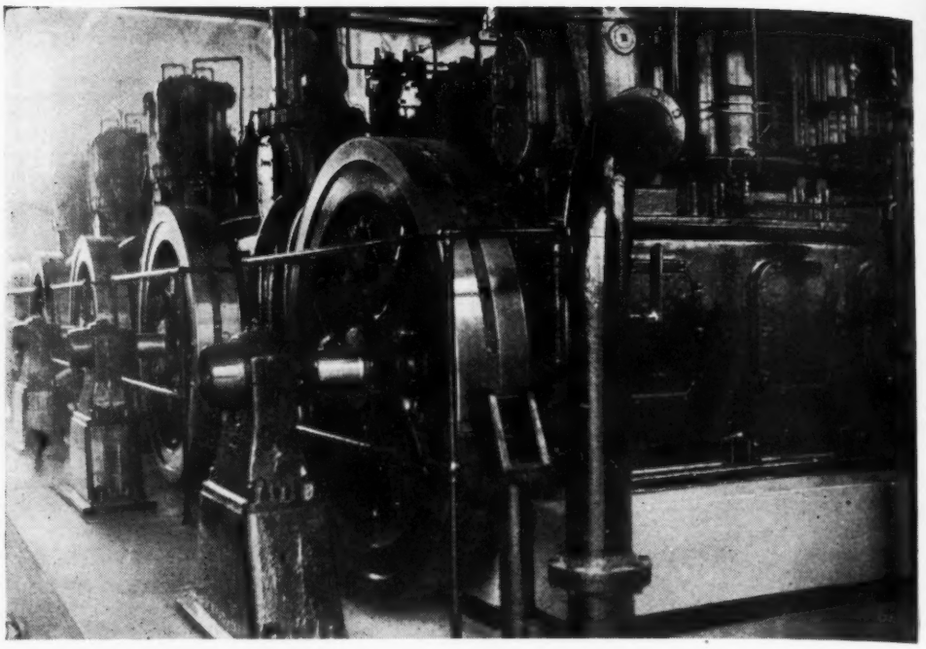
Week Ending August 25, 1934

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	500,000	85.9	14,117	12,832
Appalachian	93.3	109,000	77.9	1,613	1,358
Ind. Ill. Ky.	94.6	346,000	82.0	7,155	4,605
Okla. Kans. Mo.	83.7	240,000	62.2	4,530	3,715
Inland Texas	47.6	98,000	58.7	1,184	1,609
Texas Gulf	97.5	526,000	95.3	3,404	9,405
La. Gulf	96.4	120,000	74.1	1,221	2,456
No. Louisiana-Ark.	83.7	53,000	68.8	276	618
Rocky Mountain	66.7	45,000	70.3	718	613
California	96.9	437,000	53.2	11,902	76,063
TOTALS WEEK:					
August, 25, 1934	89.7	2,474,000	73.3	46,120	113,274
August 18, 1934	89.7	2,422,000	71.8	46,826	113,091

160-hp., 3-cylinder Hope vertical compressor units



Plant Has Equipment of 1600 hp. Capacity with Complete Auxiliaries to Handle 15,000,000 cu. ft. of Gas Daily

Natural Gas Compressor Station

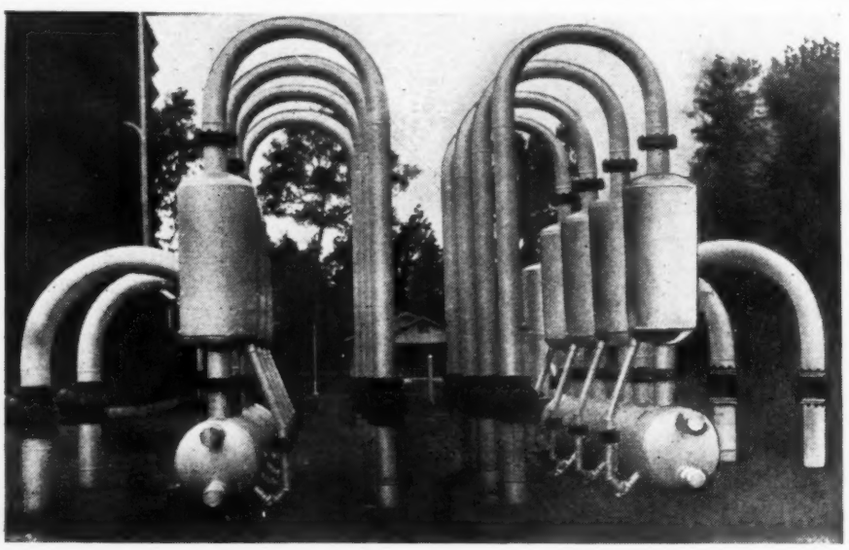
THE 1600-hp. compressor station recently completed and put into operation at Conroe, Texas, by the United Gas System is the first commercial gas outlet for that field, except for a three-mile line serving the town of Conroe. The new station boosts the gas from the field to the United's main line at Huffman through a line consisting of 8-in., 10-in. and 12-in. pipe, the total distance being approximately 20 miles. At Huffman the line ties-in to the company's main line from northeast Texas and north Louisiana that transports gas to the Houston area. The gas pumped by this station is stripped gas obtained from a gasoline plant in the Conroe field.

In designing the Conroe compressor station many details were taken into account that would add to its operating efficiency and at the same time assure a low maintenance cost.

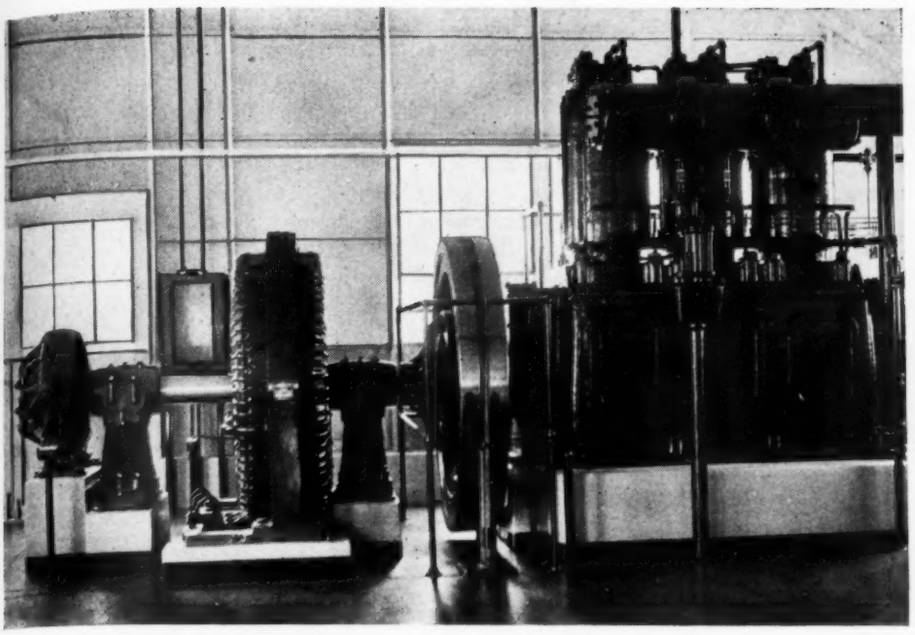
A main compressor building of steel construction houses the ten 160-hp., 3-cylinder Hope vertical compressor units. These units have a rated speed of 240 revolutions per minute. Engine main cylinders are 14¾ in. by 16 in. and the low-stage compressor cylinders 11½ in. by 16 in., with the high-stage cylinders 8½ in. by 16 inches. Engines and compressors are direct-connected. The station is designed for two-stage operation with an anticipated maximum capacity of 15,000,000 cu. ft. of gas per day at a suction pressure of 45 lb. gauge and a final discharge pressure of 315 lb. gauge. The gas header arrangement and compressor cylinder sizes permit five units to operate on the low-stage side and five units on the high- or final-stage side.

Gas to the station passes through a battery of baffle-type scrubbers before entering the low-stage suction header, so that any foreign matter in the gas may be removed before it reaches the compressor cylinders. In the scrubbers, water unites with the dirt, sand and other foreign material, carrying all through a drain at the base. After the water containing the foreign matter is thus drained off, a gate valve is opened and gas pressure blows the lines clear of any remaining substance. All connections to the scrubbers are welded and gate valves control the inlet and the discharge, the discharge side of each scrubber having four 8-in. valves and the suction side two 10-in. valves.

The low-stage units receive gas from the low-stage suction header and discharge through open-type gas coolers located in the base of a Braun cooling tower. The cooled gas, now at an intermediate pressure, which is determined by the relation of the low-stage suction pressure to the final discharge pressure,



Battery of baffle-type scrubbers



170-hp., 3-cylinder gas engine generator unit

By FRANK H. LOVE

on Recently Completed at Conroe

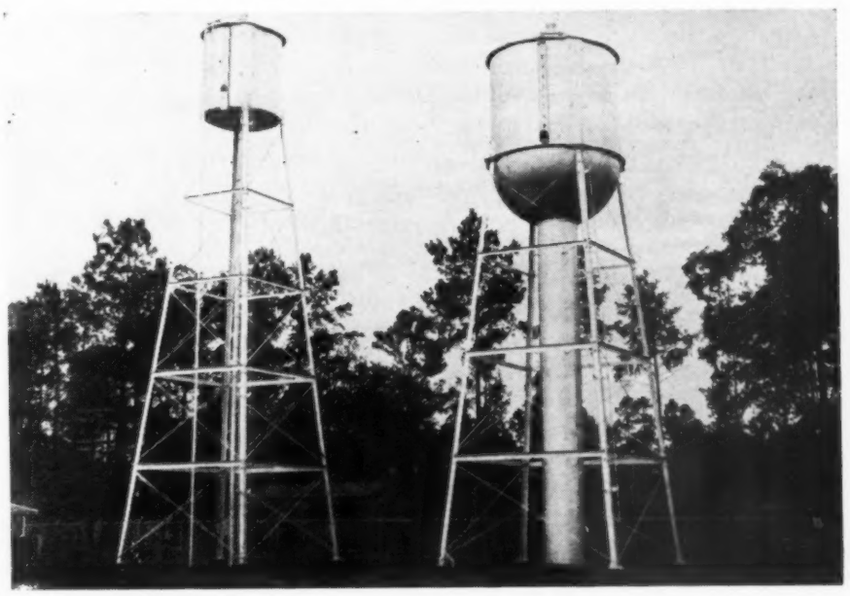
passes to the high-stage suction header and thence to the high-stage compressor units. The gas again is discharged through a set of coolers in the cooling tower and then passes, at the final discharge pressure, to the main line.

Inlet and discharge lines on the gas coolers are constructed of 6-in. pipe and connect with a 10-in. underground header. To the end of each of the 6-in. lines are joined numerous 1-in. O.D. bronze coils through which the gas circulates during the cooling process.

Suction and discharge headers are underground. The two 22-in. intake headers are joined in a manifold hook-up. An 8-in. line equipped with gate valves runs from each header to the low-stage compressors. The suction line of the high-stage compressors is of 12-in. pipe and the discharge line of 10-inch. The latter is equipped with relief valves set to pop when the pressure becomes too great. These are placed between each engine and the discharge gate.

Another building of steel construction houses all auxiliary equipment, and, in addition, provides space for a machine shop and station office. The auxiliary equipment consists of a 170-hp., 3-cylinder, gas engine generator unit for emergency use in event of high-line interruption, two motor-driven air compressors to provide starting air for all engines, four motor-driven centrifugal pumps for cooling-water, and the necessary switchboard equipment for high-line and standby generator service. A 3-phase 60-cycle a.c. generator of 440 volts, 165 amperes, 110 kva., has a rated speed of 257 r.p.m. The generator unit has a continuous duty d.c. exciter of 56 amperes and 125 volts.

All cooling water is circulated by means of motor-driven centrifugal pumps. The cold water pumps take suction from the cold well in the cooling tower and discharge to engine and compressor cylinder jackets and engine exhaust manifolds. The water then flows by gravity to a hot well, where it is picked up by the hot water pumps and then discharged over the cooling tower. The cooled water collects in the cold well and the cycle is repeated. For this service, four pumps, each capable of handling 750 gal. of fluid per minute, are employed; two pumping cold water to the engine jackets and two carrying hot water away from the engines. The pumps



Overhead water tanks in use at the Conroe Station, one of 5000-gal., the other of 15,000-gal. capacity

are driven by 15-hp. induction motors, direct-connected and developing 1760 revolutions per minute.

The cooling tower is approximately 44 ft. high, 23 ft. wide and 71 ft. long. A louver housing for the gas coolers is provided in the base of the tower. California redwood, brass bolts and tie-rods, and copper nails are used in the tower's construction. The main distribution system consists of two spray headers with two non-clogging spray nozzles for each 6-ft. section. The water is collected in the base of the tower and uniformly distributed over the gas coolers through the spray headers and nozzles. Streamline decks provide uniform wind velocity through the tower. During periods of high wind the spray loss is low, and when the wind velocity is low the proper distribution of the air by the streamline decks improves cooling.

In maintaining the lubricating oil for the compressor units, two methods are available. Each unit has an individual oil filter mounted in the line between the oil pump and the points to be lubricated, so that the oil in the crankcase is continually being filtered. A centrifuge also is provided for further cleaning of crankcase oil, the operation of which may be continuous or intermittent. Spent oil from the engines drains through a line to the first of three tanks situated in an oil house provided for that purpose. One tank is used for settling, one as an overflow tank and the other for clean oil. These tanks are square, and each has a capacity of 200 gallons. The oil is picked up from the overflow tank and pumped to the centrifuge, where all foreign matter is eliminated before it is sent to the clean oil tank of the reclamation system.

T. W. Mussett (left) superintendent of field operations in the Houston district for the United Gas System. C. F. Young (right) chief engineer of the Conroe compressor station

A 12,000-gal. horizontal tank is used for storing the lubricating oil. From this tank the oil is forced by air pressure to a small storage tank of approximately 50-gal. capacity located in the main engine room, where it is measured and forced by air pressure to the individual engine lubricators.

The lubricating system is of the overflow type. Since the life and efficiency of an engine depend to a great extent upon ample lubrication of every surface subject to wear, the compressor units in the Conroe station have a built-in lubricating system. When the engine is running, the system operates automatically. At the bottom of the main frame is a reservoir containing oil. A pump, driven off the camshaft, takes oil from this reservoir and forces it to each main bearing, crankpin and wrist-pin bearing. Secondary bearings within the frame, such as camshaft bearings and cam roller pins, also are lubricated by this pressure system. A separate force-feed system that delivers oil to two opposite points in each cylinder is employed to lubricate the pistons. The outboard bearing is ring-oiled and bearings in the valve gear at the top of the cylinders are lubricated from cup oilers.

Natural gas is used for engine fuel, two connections being available to the meter and regulator set-up, one from the suction line and one from the final discharge line. The fuel gas is measured and the pressure is first reduced to a pressure of 14-oz. by a regulator installation. After it leaves the fuel header the pressure of the fuel gas is further reduced to approximately atmospheric pressure by a regulator on each engine fuel line. Domestic gas is delivered from the main meter and regulator set-up to serve the dwellings. Gas for this purpose is reduced to a pressure of eight ounces.

A water well on the station site provides sufficient water, both for the operation of the station and for domestic purposes. The well is flowed by air to an aerating basin and then picked up by a small pump, driven by gas pressure, and forced to a 5000-gal. tank for domestic use. The station cooling water circulating system includes a 15,000-gal. surge tank that, in case of an emergency due to a short shutdown of the water circulating pumps, may be used to supply water to the engine jackets. Main water lines are of 8-in. pipe.

The prime movers are started on 175-lb. air pressure. Two 7x6x7 compressors, driven by 15-hp. motors, provide the starting air. Three underground tanks, which are manifolded, carry 250 lb. of air each, thus allowing for a surplus pressure. Each tank is equipped with a relief valve.

As the station but recently started operating, certain minor equipment is yet to be installed. The compressor units are to be provided with gas indicators. Worn piston rings, leaky valves, etc., will be automatically charted, showing exactly where and when repairs are needed, assisting greatly in the maintenance of the machinery.

Foundations and floors of the main and auxiliary buildings are of concrete, and all compressors, prime movers, motors, etc., are set in the same material. Rows of windows along the side and end walls of the buildings provide ample natural lighting and ventilation, and, in addition, ceiling lights have been installed. All light wires are enclosed in overhead conduits and each lamp is a vapor-proof fixture. Power lines are in conduits beneath the floors.

Structures on the property, other than those mentioned, are six dwellings for employees, garage and warehouse, a district office building, pipe racks and a small meter repair shop.

Fire-fighting equipment is ample, consisting of water mains, fire hydrants and hose, as well as fire extinguishers in the dwellings and station buildings. The entire plant is enclosed by a chain-link fence.

Squirrel Cage Motors for Oilwell Pumping

Mechanical Features That Affect Their Capacity

By W. C. LANE
Electrical Engineer

Fig. 1. Note construction and air channels of open type motor

AS far as the electrical characteristics are concerned, there are four types of squirrel cage motors in common use on pumping wells. These may be designated as general purpose, low-starting current normal-torque, low-starting current high-torque, and high-slip flywheel types. Any of these may be protected from injury or from causing neighboring apparatus to be damaged by the application of a suitable envelope to the motor as a whole or to the active parts. Obviously, the protective method to be applied will depend on the danger to which a motor is to be exposed and to the hazard it may create by reason of its presence in a particular location.

The chief factors governing the load a motor will carry are the mechanical strength of its parts, the torque it will exert without an excessive decrease in rotor speed, and the temperature developed in the interior of the winding. On a pulsating pumping load the temperature factor is always the limiting quantity. It is evident that the exact capacity of any particular motor will depend on the rate at which heat will escape automatically or is removed from its active parts. Any device used to protect it from mechanical injury, dust, trash, corrosion fumes, inflammable gases or liquids will to some extent reduce the ventilation and have a corresponding effect on the load capacity.

In practice, motor ratings are based on what is known as open construction as shown in Fig. 1. An open machine is one so designed that it offers no restriction to ventilation other than that imposed by the features necessary for good mechanical construction. A modern open motor with a winding so treated that it does not absorb moisture readily and constructed so that its radiating surfaces do not encourage the lodgment of dust, will stand much exposure to wind and weather. Open motors are rated on the basis of a 40-deg. cent. increase in temperature when the temperature of the cooling air is 40 deg. centigrade. The life of such a motor can be prolonged indefinitely by making a few simple common-sense provisions for keeping it dry, clean and cool. The first device to present itself for keeping a motor clean and dry, that of using a tight cover, is usually the worst possible remedy. The temperature of a motor so enclosed will continue to rise until a condition is reached that all the heat generated within it passes through the walls of the cover and escapes from the outer surface. Since the rate of transfer under such conditions is slow, an injurious temperature will usually result.

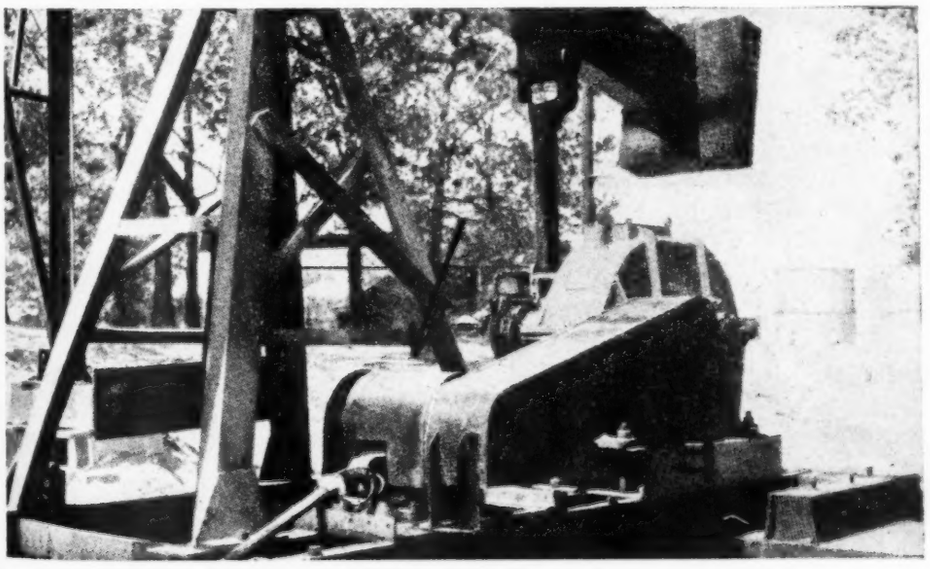


Fig 2. The cup-shaped covering used on this motor will keep off falling liquids and dirt, but unfortunately it is equally effective in maintaining a blanket of hot air over the motor.

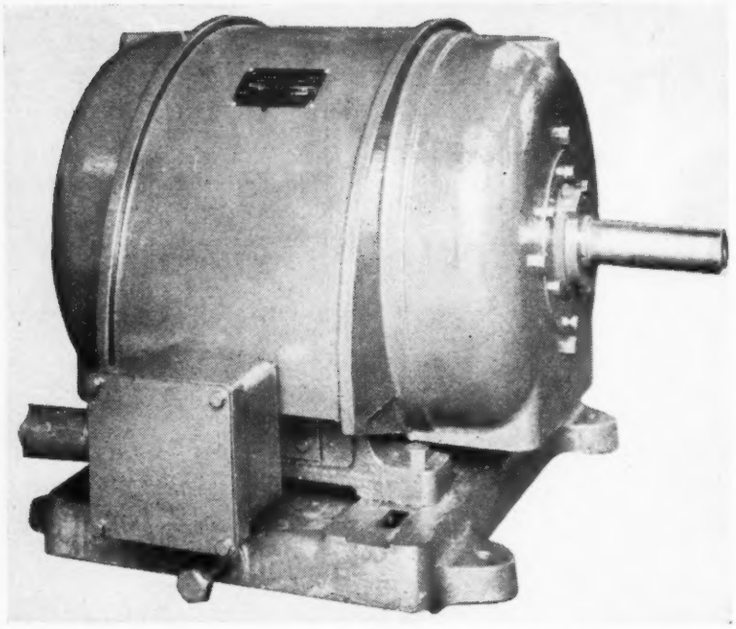


Fig. 3. A drip-proof motor made by adding protective covering to an open motor

The first question an engineer should ask himself before setting a motor to be used for pumping is not where will it be the least conspicuous and out of the way, but where will the ventilation be the best; where should it be set in order for the maximum amount of clean cool air to pass over its radiating surfaces? It should be kept in mind that hot air will not travel downward unaided in order to escape from an enclosure. For example, on a hot day the setting and the cover used on the open motor shown in Fig. 2 will probably reduce the capacity of the motor 25 per cent. The cover shown is very effective in holding a blanket of hot air over the surface from which the heat must escape. One may observe motor houses in almost any major oil field in which ample provisions have been made for the cold air to enter but the openings provided for its escape after it is heated are improperly located and inadequate. It is well to remember that the efficiency of any motor is less when it is operating at the highest permissible temperature than when it is carrying the same load at a moderate temperature, because the resistance of all parts is greater.

During the last year or two, prospective purchasers of electrical pumping equipment have been more or less confused by the indiscriminate use of such terms as drip-proof, drip-tight, gas-proof, gas-tight, vapor-proof, explosion-proof, explosion-resisting, weatherproof, splash-proof, and other kindred names indefinite in meaning. Those who are interested in an academic way may learn the exact meaning of each by referring to the NEMA Handbook of Apparatus Standards, but the layman will do well to keep only a few general principles in mind and to analyze the service to be rendered.

A large per cent of the motors in use are of the open type, as this construction gives a maximum capacity for a given amount of material. The terms "drip-proof" and "drip-tight" refer to closing or sheltering the upper half of an open motor so that its operation will not be interfered with by falling water or dirt.

The term "splash-proof" has been used rather loosely and was first applied to a drip-tight motor to which had been added coverings for the lower openings of the end housings; however, the coverings must have louvers or other openings for admitting and discharging the air so that such motors are in no sense splash-proof. In a representative design put out by several manufacturers the only channels through which air may enter are at the bottom of the end housings and these are provided with baffles so that it is impossible for a deflected stream of water to reach the interior; however, some moisture will enter but not enough to interfere with the operation of the motor. Like all open designs, splash-proof motors have fans either integral with the rotor or bolted to it to increase the circulation of the air over the working parts. Obviously the ventilation of a splash-proof motor with baffles is not so good as that of an open motor of the same construction. For this reason these motors are rated for a rise of 50 deg. cent. above the cooling air. A better way to state this general truth would be to say that the capacity of such a motor is 10 or 12 per cent less as a result of the use of this construction; however, all open motors are given a so-called 15 per cent service factor, and when made splash-proof they can be given the full nominal hp. rating but they will have no overload capacity.

One manufacturer has attacked the problem of dust and moisture elimination in another way. The winding of the motor is treated with a waterproofing compound and the ends of the coils are enclosed in metal sheaths whose cross section is U-shaped. Surfaces and air passages are so designed that moisture and dust do not collect readily. The idea is to procure the greatest possible capacity from a given motor without restricting the ventilation. The metal sheaths prevent air from circulating through the ends of the stator coils but on modern motors this area is usually closed by an insulating compound so that the escape of heat is probably increased because of the greater heat conductivity of metal. Comparative tests of this type of motor under extreme conditions of moisture

Fig. 4. A totally enclosed fan-cooled motor. When so enclosed the rating of a motor is reduced about 15 per cent

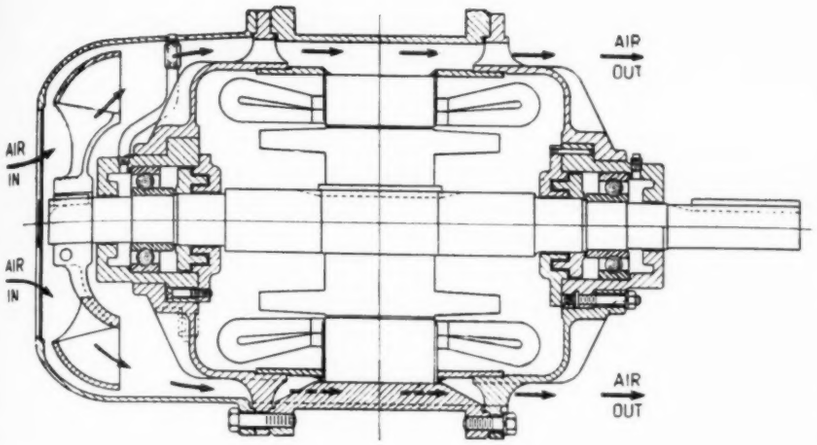


Fig. 5. Cross section of an explosion-resisting motor showing the provisions made to prevent the escape of a flame in case an explosion should occur within the motor

are said to indicate that the winding absorbs less moisture than the splash-proof design from which the moisture escapes less readily.

The totally enclosed motor was developed many years ago to operate in extremely damp or dusty places. The idea was to keep liquids and dirt out by using solid frames, end housings, and suitable glands. Since all the heat generated within must pass out through the solid walls and be dissipated from the outer surface, it is evident that a much larger motor is required to perform a given operation than would be needed under normal circumstances. An open motor enclosed in this manner has its rating cut about 50 per cent. As a remedy for this situation the modern fan-cooled motor was developed.

It may be said that it is impractical to attempt to make a totally enclosed commercial pumping motor either water-tight or gas-tight on account of the action that takes place in the air space within the case when the motor is started and stopped. When a motor is first started the air within it expands as a result of the heat generated, a pressure is built up within the case and a gradual leakage of the warm air will take place toward the outside. When the motor is stopped and allowed to cool, the air within it will cool, thus causing a partial vacuum to form and a leakage of water vapor, air, and gas, if it be present, will take place from without. Some of the moisture will condense; the gas that enters will replace some of the air and an explosive mixture may result.

The principle of the totally enclosed fan-cooled motor can be understood best by a reference to Fig. 4. Imagine that a totally enclosed motor is enclosed in a second envelope somewhat larger than its outer contour and that an air space exists between the two. A fan, pressed on the shaft extension of the motor forces a blanket of air through the modified annular space between the two shells, thus increasing the ventilation very materially. The ventilation provided in this manner is not so good as that obtaining on an open motor, so that motors of this kind are rated for an increase of 55 deg. cent. in temperature. A safer thing to remember is that the capacity of a given motor is reduced about 15 per cent when this construction is used.

Fan-cooled motors are built for two operating conditions: where they must be protected from outside injury, such as from dust and fluids of any kind, and where they constitute a hazard and may ignite inflammable vapors and cause an explosion. The former are called dust-proof, and since the difference in the pressures within and without a motor is nominal and it is easier to protect it from the entrance of foreign material, fewer precautions are necessary and a lighter, simpler construction is permissible. Fig. 5 illustrates the cross section of a motor of explosion-resisting design and Fig. 6 shows the outer appearance of the protecting frame. The leakage paths around the fitted joints of the end housings and along the shaft are shorter and less elaborate on the dust-proof design than on the section shown in Fig. 5. A better construction is used throughout on the explosion-proof type, more studs are used in fastening the parts together and non-sparking fan blades are used to eliminate any chance of stray sparks being produced by steel striking steel. A design is tested for what one may call fire leakage at the joints by inserting a spark plug within the case and exploding gaseous mixtures.

It should be noted that reputable manufacturers do not use the term vapor-proof, but explosion-proof or explosion-resisting in describing the totally enclosed, fan-cooled motor with long mechanical joints and heavy construction. Vapor-proof, commercial motors are not built, for the action, described in another paragraph, causes the entrance of some gas if it is present in the area. It has been determined by experiment just about how rich the mixture will become in a motor operated in a gaseous location and a construction is used that is ample to withstand an explosion produced by such a charge. It appears that "explosion-resisting" is the better term to use since that is what a design is expected to do.

One advantage of this construction was emphasized very forcibly a few months ago in a fire in a gasoline plant near Seminole, Oklahoma. Twelve 7½-hp. explosion-proof motors were in the area swept by the fire and despite the fact that the heat was so intense it melted the brass work of a number of gauges in the fire area, none of the motors was seriously injured. As a precaution they were redipped and rebaked before being put back in service. Pumpers should be taught to use thermometers, and in hot weather should be required to observe the temperature of the more heavily loaded motors on a lease in order to anticipate trouble. Motors are expected to get hot but the term "hot" gives too much room for guess work. When the surface of a motor approaches the temperature of boiling water, 100 deg. cent. or 212 deg. fahr., it is time to take remedial measures.

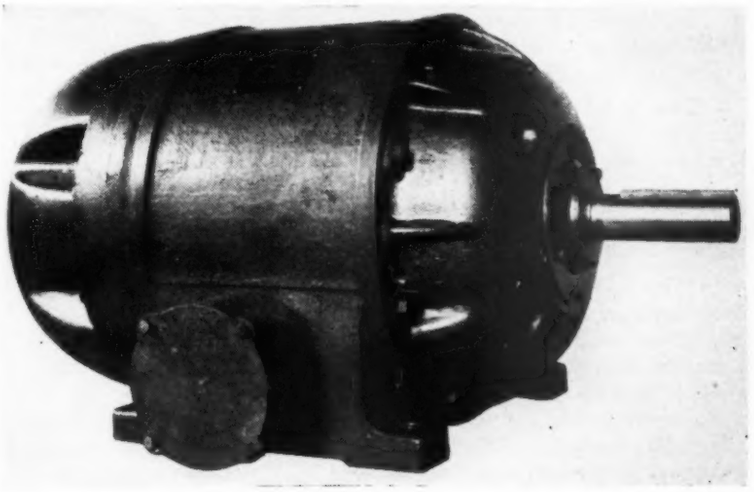


Fig. 6. Exterior of explosion-proof motor. Note mechanical strength of castings and number of studs used to hold parts together

Proficient Procedure in Handling Industrial Research Problems

By

MICHAEL J. LEAHY

In this article the author, in discussing the proficient handling of industrial research problems, outlines the procedure involved in obtaining patents and points out how possible futile expenditures in the development of patentable industrial processes may be avoided.

The author is well qualified by training and experience to discuss this subject, being a graduate engineer in mechanics and chemistry. He was for a time Assistant Professor at the University of Arizona in charge of the Oil Research Laboratory, and for several years has been in private practice in Fort Worth, Texas, where he is at present engaged in petroleum and industrial research.

IN recent years the pace at which modern industries have been advancing has been greatly accelerated; and hence research—both of the laboratory and of the commercial type—has become a vital, but very complicated, part of every industrial organization. This is particularly true of the petroleum industry, combining as it does intricate problems in mechanics and in both organic and inorganic chemistry. The larger and so-called integrated oil companies each maintain a modern research and development department, and many of them also maintain departments for patent research and for the prosecution of patents on inventions made by their own employees. The expense incident to the support of such departments on a continuous basis is greater than most of the smaller oil companies can afford; hence such companies must perforce attempt to solve their research problems more or less blindly or else depend entirely on obtaining licenses to operate new processes from the owners of patents thereon. This, of course, means that the royalty payments that must be made on such patented processes become added burdens on the licensees.

Further, as frequently happens, if an employee of a company that is not large enough to support a patent department does conceive an invention that his employer feels would be of value if developed and patented, such employer is immediately faced with the following problems:

1. Should I spend further effort and money immediately in developing the invention and reduce it to commercial practice as soon as possible?

2. If I do assist the inventor to develop his idea, what rights, if any, will my company have in the invention?

3. How shall I determine if the idea is an invention and not simply a new arrangement of well-known parts, formulas, or combinations of matter?

4. How should I assist the inventor to obtain proper patent protection, and how soon may I expect final patents to issue thereon?

The purpose of this article is to point the way to the correct answers to the above questions and hence to the most economical method of handling industrial research.

Question 1. In most cases it is preferable that just enough experimental work be done on the invention to show that the basic idea thereof does not conflict with the laws of nature, physics, chemistry, etc. After this has been demonstrated, the inventor himself should then write a complete description of his invention and have this description read and signed by at least two competent witnesses. This is very important, as only thus can the actual date of invention be established.

If the invention relates to a process, necessarily certain apparatus must be employed in reducing the process to practice. The inventor may have sufficient knowledge of mechanics to design or invent such needed apparatus. In most cases, however, he does not have such mechanical training and hence the invention is incomplete without the proper apparatus. In either event, a very thorough search of prior-art patents, both U. S. and foreign, should be made at this time and this search should be extended to include both process and apparatus patents.

In this connection it may be pointed out that the number of patents that have been granted on processes and apparatus relating to the petroleum industry alone is almost beyond comprehension. For example, in the period between January 1, 1913, and June 1, 1933, there were in the United States alone, at least 1366 patents granted on processes and apparatus for the refining, treating, or cracking of petroleum. Further, during the same period, there were at least 178 U. S. and foreign patents granted relating directly to processes and apparatus for the production of carbon black from natural gas. Many of these patents have complicated drawings and describe and claim very intricate chemical formulas. It therefore requires several months of study to read and then to classify the specifications and claims in this multiplicity of patents. Manifestly then, it requires the special knowledge of a trained mechanical engineer properly to understand and classify the apparatus specified; the technical training of a chemist to study and classify the chemistry involved in the specified processes; and the special training of a person experienced in determining the meanings of the peculiar nomenclature used in patent specifications and claims, in order to ascertain if an invention relating to the petroleum industry especially is patentable over the prior art and if so, the broadness of the claims that may be made thereon.

A patent search such as outlined will reveal: (a) That the invention has been patented for more than 17 years prior to the date of the search, in which case the monopoly granted to the original inventor has therefore expired and anyone may use the invention without payment of royalties or damages; or

(b) That the invention has been patented by another within a period of 17 years and therefore the invention may not be used by anyone except the original inventor or except under grant from him; or

(c) That the invention has not been described or claimed by anyone in the United States or in foreign countries or has not been in public use. In this case, it is a wise policy to continue the search by checking through the literature published on the subject of the invention; especially up to a

period of less than two years prior to the date of the invention. For it is well known that if an invention has been described in any printed publication more than two years prior to the date of an application for patent thereon by anyone, any patent that may then issue will be invalid.

If a thorough search of both the prior-art patents and the technical literature does not reveal any description of the invention, then the person who has made the search and the inventor himself should collaborate in making any drawings needed and in writing the specification and claims for an application for patent on the invention. If the claims are verbose of necessity, it is well to have a registered patent attorney check such claims carefully to determine if the phraseology used therein complies with Patent Office requirements.

One should not, however, expect a patent attorney to make a search as outlined above; as any registered patent attorney must of necessity accept applications for patent on inventions pertaining to every branch of the sciences and arts and therefore cannot be expected to have a specialized knowledge of the applied mechanics and the specific chemistry required in each industry.

In most cases, as soon as an application for patent, properly drawn up, has been filed in the Patent Office, it is safe and wise to continue with the experimental work on the invention in order to reduce it to commercial practice promptly.

Question 2. In some instances, an employer does have a vested right in the inventions of his employees, in other cases he does not. Therefore, it is always a wise policy for an employer to have a written agreement with each employee who may be engaged in experimental or research work specifying exactly the rights of both the employee who may make an invention and the employer who may benefit thereby. Care should be exercised in drawing up such an agreement to make certain that it is equitable to each party; especially the inventor. It seems, from a study of the latest decisions of the higher courts, that such courts lean more and more toward giving the inventor full benefit of any doubtful points.

Question 3. This question can be fully answered only after a final patent has been granted on the invention and such patent adjudicated. However, if the specification and claims have been carefully drawn up by one who has expert knowledge of the mechanism, the chemistry, and the Patent Office nomenclature involved, the probability that the final patent will be adjudged inoperative or invalid is very remote.

Question 4. The first part of this question has already been answered in that the employer may assist the inventor, and himself, greatly by engaging a competent patent research engineer to determine if the invention is patentable; to assist in drawing up the proper specifications and claims; to aid in the design of apparatus for the commercial application of the invention; and to render expert advice and testimony in any litigation that later may be instituted by his competitors or by other inventors.

The second part of this question may be answered only by saying that it seldom happens that a final patent is granted nowadays on an invention of value in a period of less than eighteen months from the date of the application for patent. However, while it is true that the inventor has no legal rights in a patent until such patent issues to him, it is also true that any infringer likewise has no legal protection and is liable for damages for the entire time he infringes even though such time extends back to the date of the invention.

Summarizing, it may be said that before spending much money and time on any research problem, the head of an industrial organization should see that such problem is clearly outlined and the goal sought clearly defined; all patent and technical data on the subject should be assembled and studied and if such study reveals no practical solution to the problem, then, and then only, should extensive experimental work be started on the problem.

As soon as such experimental work is under way, great care should be exercised to preserve all records of the work; so that if any inventions are conceived the proper parties may get credit for such inventions and that the dates thereof be legally established. If patent protection is desired or required on any such inventions, too much care cannot be exercised in the preparation of applications for patent so that real patent protection may be obtained. It is an old axiom that a patent is only as broad and legal as its claims. Therefore if the claims are invalid or ambiguous, the patent itself is invalid.

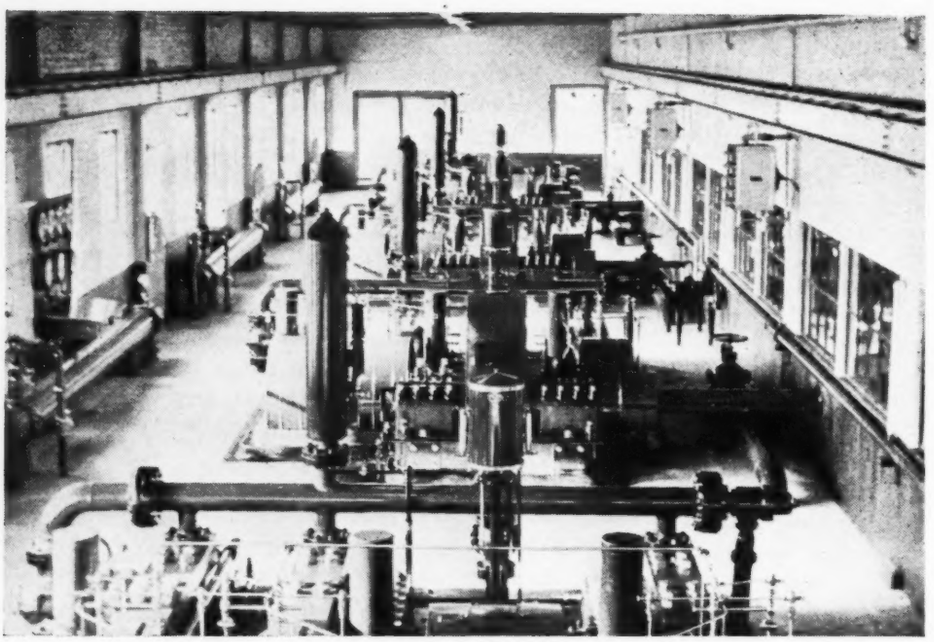
As an illustration of the pressing need, especially in the oil industry, for more improved methods for the solution of practical research problems, the author wishes to cite but one of the many cases of misapplied energy and funds that have come under his observation in his work:

About seven years ago an independent oil company with a surplus production of "high-sulphur" crude built an up-to-date refinery and established a tank-car market for the gasoline produced therein. Gradually, complaints regarding the corrosiveness of this gasoline began to multiply and experiments were hastily started on attempts to correct this condition. Almost every idea suggested by any of the employees was tried but without success. Finally an employee in the laboratory who was engaged exclusively on the routine testing of refined products suggested the use of insoluble metals or metalloids for sweetening the gasoline.

Experiments were therefore conducted along these lines and indications pointed to the use of certain of the elements in Group I of the Periodic Table. The problems of the cost of these elements, the danger involved in handling them and the recovery of spent materials, all pressed forward for solution. Each in turn was solved more or less satisfactorily in small-scale operations. Finally the company built a semi-commercial treating unit and operated it for some time. Due to the fact that laboratory operating conditions can seldom be duplicated in commercial operations, much expensive equipment was bought, tried for a time and then hastily discarded for still other equipment.

In the meantime, the inventor of the process left the employ of the company and it is assumed that he took his original records with him. At least no records could be found that could be used as evidence of the date of invention. Likewise, neither the company nor any of the employees made any effort to obtain patents on the process or on the equipment used.

Less than a year ago, after spending a sum estimated at more than $200,000 experimenting with the process, it was finally decided to commercialize it and obtain patent protection. A patent search of less than two hours revealed that several patents had been granted on the identical process. These patents were owned by a large company that would not consider licensing the smaller company to use them. An exhaustive search then revealed that there was no legal way of getting around these patents without definite and conclusive evidence of prior invention. Since this was impossible, the years of effort and the large amount of money that had been expended on the process by the smaller company were alike entirely wasted.



Pump room with four reciprocating pumps direct-connected through firewall to 325-hp. Diesel engines. Enclosed heat exchangers shown against the outer wall

By

J. L. INGRAM

Article I

Maintaining Diesel Engine Room Efficiency

AN operating engineer of a Diesel plant of any size, marine or stationary, knows it is an impossibility to predict all the conditions that may arise in the engine room regardless of the amount of auxiliaries used. Problems of an extremely serious nature may arise in one engine room, while in another, using the same equipment, it will be non-existent, and the possibilities of derangement cause so little trouble as to be unimportant. What the engine operator is really interested in is whether the machinery in his care is gradually building up a condition that eventually might result in trouble, shutdowns, and major repairs, and just exactly what can be done to remedy such a condition and help maintain the machinery somewhere near its original efficiency.

Importance of detail has long been recognized in the design and installation of Diesel power. Engines made from the best of material and with the greatest care are sometimes installed under such adverse conditions that the whole success of the plant rests upon the ability of the operating personnel.

There is considerable difference in the operation and maintenance of the stationary Diesel plant and those found aboard ship. The rigid economy practiced on board some merchant ships would apply equally well on board some oil tankers and in some of the stationary plants. Frequently the stationary plant operator runs into a condition, although new to him, that is more or less an everyday occurrence with the larger sea power. Owing to the amount of maneuvering necessary, and the heavy investment represented in a large vessel, it is obvious that the engines must be kept in such a state of repair that they will start instantly in either direction. One not accustomed to weathering a storm in the engine room of an oil tanker cannot realize readily the conditions under which engines of approximately 4000 hp. are forced to operate. Rolling from side to side, first on one end and then on the other, they cannot be permitted to stop. Much is to be gained, however, from the experiences of the stationary plant operator and the marine engineer that will prove of benefit to the other.

The stationary engineer has an advantage over the marine engineer in that the former has little worry over loss of life or property in case of engine failure. Little attention has to be paid to the quality or the quantity of the lubricating and fuel oil. The oil companies usually furnish their best product in abundance.

Aboard a merchant vessel B.t.u. tests of the fuel oil must be made frequently, and when purchased in a foreign port must be watched closely, as a sample of good oil sometimes will be delivered aboard ship for test and a very poor grade pumped into the fuel bunkers. It also is important that tests be made of the lubricating oil upon delivery. Tests of purchased water is just as important, if not more so, than that of oils. Water sellers in some of the foreign ports are exceptionally clever. It sometimes happens that they make an effort to get one confused with their measurements, then

THE AUTHOR

J. L. Ingram, author of this article, is a licensed Marine Chief Engineer, unlimited. He spent more than ten years at sea, on both oil tankers and merchant vessels, as a Diesel engineer and machinist, and is now employed by one of the major oil pipe line companies. His articles are thus based upon a wide practical experience, gained from his activities on both land and sea.

bring a 10,000-gal. water scow alongside, supposedly full of clean, fresh water of which a good sample is delivered to the watch engineer for test, but as soon as the pumps are started a hidden sea-valve is opened and 15,000 or 20,000 gal. of "fresh water" is purchased from a 10,000-gal. scow in one delivery. Usually this is not discovered until the vessel is several days at sea. This procedure is not practiced entirely outside the United States either.

Many of the marine companies use a low grade of fuel oil or a regular boiler oil. These economies do not in any way cause deficiency in the operation of the engines. The slight addition to maintenance cost is more than offset by the amount saved in the purchase of fuel. This would be impossible if it were not for the purification of the fuel oil and the engineers being constantly on the watch for trouble, and the making of minor adjustments that, if neglected, soon would develop into something serious. Success depends upon the operating ability of the crew.

Bearing Adjustment

Bearing adjustments are too often looked upon as a matter of course by officials, as well as the station operator, and frequently are made by guess with little thought of what takes place within the shell. A bearing of any kind usually is made of sufficient size to withstand the load to which it is submitted. If this area is reduced by any considerable amount, more heat will be generated in the bearing than the metal can stand and extreme measures will have to be taken to keep it cool and prevent wiping. As the four drawings in Fig. 1 show, a film of oil must be maintained between the moving and stationary parts of a bearing while it is in operation; and the heat generated during operation must be carried away. Fig. 1 shows the clearances greatly exaggerated in order to illustrate the formation of the film of oil. While the journal is standing at rest the oil is squeezed out by the weight of the shaft and contact is at the bottom, "C," as shown in Fig. 1 (a). As the bearing starts up it tends to roll towards "a" as shown in Fig. 1. (b). The thickness of the oil film is increased, tending to lift the shaft from the bearing and let the weight rest upon the oil, as shown in Fig. 1 (c). Experience shows that the oil takes the position shown in Fig. 1 (d) with different pressure areas throughout the bearing that shift until forces are in equilibrium. Changes in temperature, with consequent changes in the viscosity of the oil, produce some variance in the thickness of the oil film and the position of the journal. The oil must be of such quality and quantity as to be able to remove this heat from the heat-generating surface of the shell, provided no other cooling system is employed.

Because of the importance of lubrication in its relation to the efficient maintenance of machinery of any kind, and to prevent casualties due to lack of proper lubrication, it is a splendid idea around the larger plants for the operator to make a chart for each machinery unit containing the operating temperature of the oil, symbols of the different lubricants used, quantities and points of use, intervals of supply, and also giving all bearing clearances, operating hints and other pertinent information.

Bearing adjustments are less frequently required on the Diesel engine than on the steam engine. This is due to the method of Diesel engine lubrication. The influence of bearing clearance on the performance of the engine demands that the bearing adjustments be carefully and skillfully done. Although adjustments are simple and consist mainly of alignment, fitting, and grooving, continual and serious trouble may result unless they are properly carried out. A marked departure from correct alignment cannot long continue without damage to the material and failure in operation. It is for this reason that precision instruments for facilitating the immediate and exact determination of a state of alignment are furnished by the users of larger power. In the reciprocating engine the lack of alignment and misfit bearings usually are indicated by additional noises and by the generation of additional heat long before damage occurs. The assumptions that if no pounding or knocking is heard while the engine is operating under load, that the bearings are not running hot, or that the bearings are properly adjusted, are not always correct. The bearing of a 2-cycle engine may be worn down sufficiently to lower the compression without producing knocks or generating additional heat, because the pressure on the major bearings are always downward. The crankshaft of either the 2-cycle or the 4-cycle engine may be dangerously out of line due to uneven bearing wear and still operate noiselessly.

The clearance should be uniform over the entire bearing, except that it is usual with large bearings to "crown the brass," that is, to allow a slightly larger clearance at the sides that tend to prevent the loss of oil in the bearing. Crowning also prevents the journal from being "nipped" in case the bearing runs warm, at the same time making it easier to handle the brass on and off the shaft during the process of fitting. If this clearance is not uniform, only a part of the bearing will take the load and the friction on the limited surface of that part will cause the bearing to warm up or become hot while running under load. The aim is to reduce the clearance to a minimum and at the same time insure sufficient play to prevent heating. The clearance of the bearing naturally depends upon the general alignment of the shaft, size of the bearing, gravity or forced-feed lubrication, speed of revolution, and whether the direction of the load

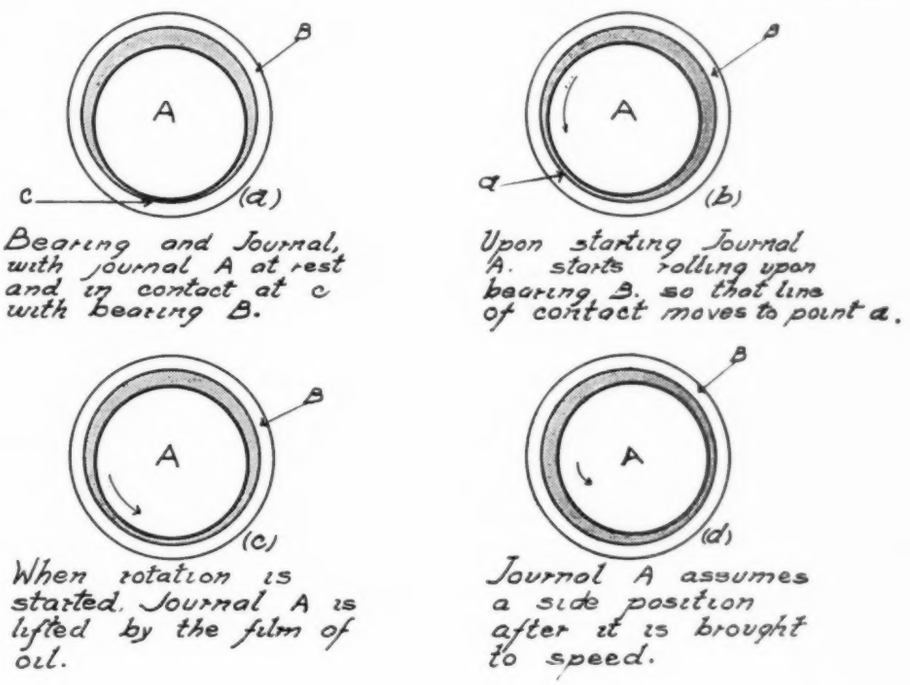

A
B
C
(a)
Bearing and Journal, with journal A at rest and in contact at c with bearing B.
A
B
a
(b)
Upon starting Journal A. starts rolling upon bearing B. so that line of contact moves to point a.
A
B
(c)
When rotation is started. Journal A is lifted by the film of oil.
A
B
(d)
Journal A assumes a side position after it is brought to speed.

Fig. 1

force alternates as in reciprocating units or remains stationary as in rotating units.

Considerable difference of opinion often arises relative to the amount of running clearance that a bearing should have. Experience shows that some engines will run smoothly with a clearance that will cause others to run hot. The question is best determined by actual operation of the engine. It is customary for the engine builder to specify certain clearance for the most important bearings, but in absence of this, or actual experience with a certain bearing, the following may be used as a safe clearance guide: Diameter of the bearing in inches $\times$ 0.0005 in. + 0.002 in. = a safe operating clearance.

In fitting up a bearing care should be taken to see that the nuts and bolts go back into the same place and piston from which they came. The writer had the opportunity of working in a large engine factory for a short time. Here one finds that even the bolts—usually considered of least importance—are turned over-size, blued and draw-filed to a marked fit. A good machinist usually will carry a small set of numeral stencils for marking purposes. Punch marks are not always correct, for after several adjustments the nuts and bolt heads are so marked up that a new punch mark is of little value. A good method of installing permanent reference marks is to graduate the nut collar and number each graduation. In selecting the number of graduations desired, the number of threads to the inch of bolt must be taken into consideration. For instance, if the latter is found to be four and graduations representing 10/1000 are desired, the number required is 25, because each turn of the nut sends it 250/1000 along the bolt; 1/25 of 250/1000 = 10/1000. This saves disfiguring the marking surface on the nuts.

Experienced engineers often become expert in guessing the crank and crosshead clearances by "jumping" the rod. In such cases crosshead and crank bearings are scraped in and fitted, just a sufficient number of liners being inserted to insure that when the nuts are set up "full due" the rod will slowly swing to a vertical position if the crosshead pin is held stationary and the rod swung toward a horizontal position when released. Good workmanship consists of measuring the bearing clearances with soft lead wire, then measuring the thickness of the flattened wire with micrometers. In doing this the reference marks should be noted and the bearing cap not brought down tight enough to strain the bolts. In using a lead wire it should be remembered that if the wire is too hard it will be squeezed into the soft metal of the bearing shell and the thickness will be greater than the actual clearance. The use of strips of sheet lead, solder, and fuse wire for taking clearances is bad practice.

When taking a true lead of a bearing clearance, all bolts, bolt holes, bearing surfaces, butting faces, and shims must be free from foreign matter of all kind. In setting up the nuts of a large bearing, ordinarily a short, heavy wrench is used with a light sledge. To the experienced, the feel of the sledge striking the wrench when the nut is home, combined with the movement of the nut, indicates when to stop hitting. The same person should handle the sledge on the same bearing as he is better able to judge the force of the blow and draw each of the bearing bolts up evenly.

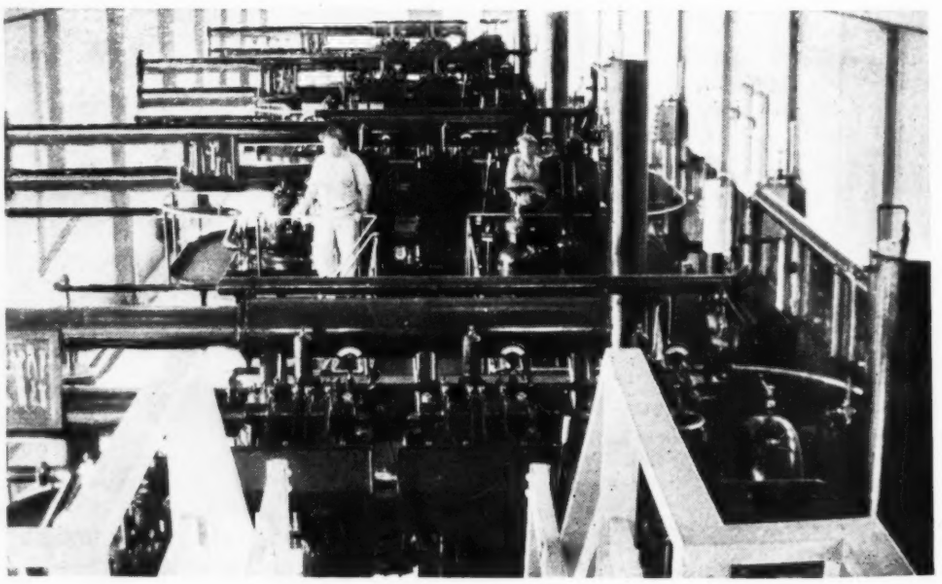
Valve-grinding compounds should not be used on the valve stems, plungers, pistons, or in fitting up any bearing, large or small. The fine particles of cutting material work into the soft metal of the bearing and cannot be washed out, and future trouble can be expected. Some of these particles free themselves and work into other moving parts of the engine to continue their destructive work. In the absence of an approved bearing or lapping compound the following mixture proves very satisfactory:

Finely pulverized silica (SiO_2) - - -	45 parts
White lead ($Pb(OH)_2$) - - - - - -	40 parts
Sodium carbonate - - - - - - - -	6 parts
Lampblack - - - - - - - - -	5 parts

Particular care must be taken to prevent any compound from getting into the lubricating system, as they contain silica and lose none of their abrasive properties during the process of grinding. It is essential also that the bearings be washed with a solvent such as gasoline.

The heating of a bearing is the danger sign. If it takes an hour or so for a bearing to reach a temperature uncomfortably hot for the hand it is probably safe enough; however, if it reaches the same temperature within a few moments, trouble is in the making. As a general rule, bearings can be run much hotter than ordinarily supposed; in many cases bearings too hot to permit holding the hand on will operate satisfactorily.

One of the quickest ways to judge the experience of a mechanic is to watch him using valve-grinding compound and prussian blue. In many cases I have seen enough compound used on one valve to grind in a gross. Prussian blue is often piled on a bearing until a solid blue is obtained; and the false opinion is that a perfect bearing surface results. Many highly skilled men will not use blue at all, but depend upon the bright spots on the bearing surface to show the high spots. If blue is used and true results are to be obtained it must be used sparingly. A small quantity should be rubbed over the entire babbitt surface with the finger tips. After it is on even, most of it should be wiped off until there is only a faint trace of the blue left. In this manner the points of contact show plainly. The writer has never been able to scrape all the little high spots down in the bearing metal and make a perfectly smooth fit. If these little points of contact cover the whole bearing surface it can be considered a good job, as it soon will wear down to a solid surface after running and a nice fit result.



Engine room of a modern pipe line station

The Significance of Light Translucency

Of Thin Adsorbed Films of Lubricants and Other Oil or Oily-Feeling Products

By S. FISCHER and EDWARD MARINOFF

Article III

EXPERIMENTAL WORK (Continued)

V. *Carbon Formation and Percentage Light Translucency of Thin, Adsorbed Films.*

In the course of the work in connection with the 500- and 1032-mile test runs, as well as with the percentage light translucency decomposition tests, it was necessary to filter the used and decomposed oils before measuring the percentage light translucency. It was observed, that some oils showed more carbonaceous residue than did others.

This led to the belief, that by filtration, it might be possible to show photographically the relative differences in the amount of carbon residue.

Procedure: Fifteen cc. of the following oils were measured accurately and diluted with 75 cc. of ether in a separatory funnel. The samples were shaken well and filtered through identical filter papers. The residues were washed with ether until no further oil was present on the filter. The filters were then dried and photographed. The results are shown in Fig. 9a. The oils used are designated as E, D, F and G of Table No. II represented in Fig. 6 by the corresponding numerals, and as A, B, and C of Table No. III represented in Fig. 7 by the corresponding numerals. The filters containing the carbonaceous residue after the ether wash as in Fig. 9a were subsequently washed with xylene, chloroform, acetone and carbon bisulphide. These respective washings were made to remove the presence of any products such as asphaltic constituents, which may have been present along with the straight carbon. The filters after washing with the above solvents were dried and rephotographed and represented in Fig. 9b. The letters below each filter correspond to the same sample with just the ether wash as in Fig. 9a. See Table IVa.

Observations: 1. Evidently, there is practically no decomposition for oil 26(B), a trace 21(C) and a marked decomposition for oil 34(A). This appears to be a visible proof that the common point of intersection of the percentage light translucency—viscosity curves for all Pennsylvania, paraffin base oils, with the exception of the highly-filtered oils, is a fact. See Fig. 7. Photographs A, B. and C are actually a pictorial representation of the curve of the corresponding oils 34′, 26′ and 21′.

2. It seems that the specially-treated, clay-filtered naphthene base oils, IV′(F) and V(G), Fig. 6, Table No. II, although having a high initial value of percentage light translucency, break down considerably more than do Pennsylvania, paraffin base oils, II(E) and III(D), under like conditions. Even oil 26′, Fig. 7, photograph C Fig. 9a and 9b, although run over twice the distance under similar conditions, shows only a trace of carbon, while oils IV′ and V′ Fig. 6, photographs F and G, respectively, Fig. 9a and 9b, show a decided decomposition in terms of carbon at one-half the mileage.

VI. *Neutralization Number and the Percentage Light Translucency.*

Procedure: A series of oils were heated to 250 deg. cent.

TABLE NO. IVa

Pennsylvania Paraffin Base Oils Run 1032 Miles Under Identical Conditions. (See data in Table No. III)

SAMPLE	Loss in Percentage Light Translucency (see Table No. III)	Viscosity (S. U.) Seconds at 210° F.
A	14.46	54
B	1.09	65
C	2.34	74

Two Series of Oils Run 500 Miles Under the Same Conditions. (See data in Table No. II)

Type of Oil	Sample	Loss in Percentage Light Translucency	Initial Viscosity (S. U.) Seconds at 210° F.
Penn. Paraf. Base	E	6.01	85
	D	8.54	95
Western Naphth. Base	F	38.13	69
	G	62.28	79

TABLE NO. Va

The effects of temperature upon the neutralization numbers and upon the percentages light translucency of processed oils.

Ref. No. of Oil from Table I.	Initial Values		After Treatment with Process 1.			
				Temperature		
	% L. T.	Neut. No.		25-250° C.	300° C.	350° C.
40	88.48	0.08	Neut. No.	0.05	0.15	0.25
			% L. T.	94.53	94.53	88.48
28	38.17	1.50	Neut. No	0.30	1.05	1.25
			% L. T.	90.60	90.60	58.70
29	57.18	0.92	Neut. No.	0.019	0.65	0.80
			% L. T.	90.35	90.35	90.35

TABLE NO. Vb

The effect of processing upon the neutralization numbers and upon the percentages light translucency of oils.

Process Used	Oil Samples (Ref. Nos. from Table I.)					
	Oil No. 40		Oil No. 28		Oil No. 29	
	Neut. No.	% L. T.	Neut. No.	% L. T.	Neut. No.	% L. T.
Initial	0.08	88.54	1.50	38.17	0.920	57.18
Process No. 1	0.05	94.53	0.30	90.60	0.019	90.35
Process No. 2			1.15	88.94		

For above processes, see VIII, "Increasing or Rejuvenating the Percentage Light Translucency of Oils."

(482 deg. fahr.), 300 deg. cent. (572 deg. fahr.) and 350 deg. cent. (662 deg. fahr.), respectively, and determinations of their percentages light translucency values were made. The samples were than submitted to Smith & Emery Co., a nationally-known chemical research and analytical laboratory at Los Angeles, California, for the determination of the neutralization numbers of these oils. The results are given in Tables Va and Vb.

Observations: It would appear, from the results obtained, that the neutralization number increases with decreasing percentage light translucency.

VII. Processing and Percentage Light Translucency.

This phase of the investigation is rather a discussion of the results already obtained. It has been mentioned, previously, that a study of the gravity (A.P.I.)—percentage light translucency relationship can hardly be utilized in determining differences in processing. However, the viscosity (S.U.)—percentage light translucency relationship, appears to give information whereby, after becoming accustomed to the various differences, one is able to distinguish between oils that have been treated in the ordinary manner or whether they have been treated by vacuum distillation or some type of filtration process. See Fig. 3, Table I.

The decomposition curves for percentage light translucency also lend themselves in gauging the type of treatment an oil has undergone, as has been indicated under this particular investigation. See Fig. 10 and also Table VI and Table I for the respective types of processing for the initial oils.

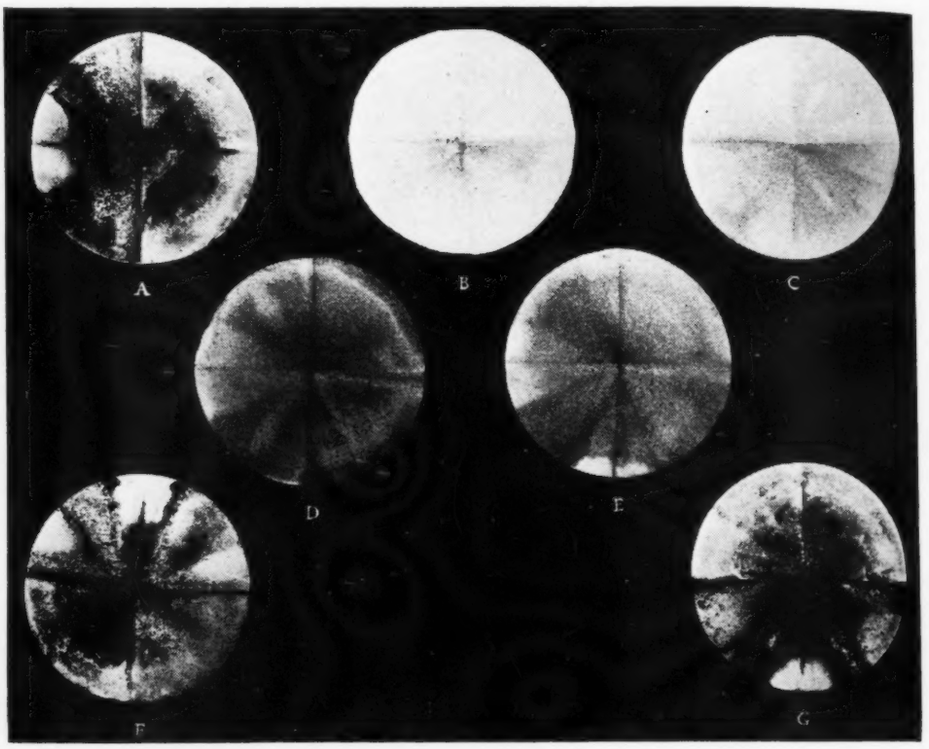
VIII. Increasing or Rejuvenating the Percentage Light Translucency of Oils.

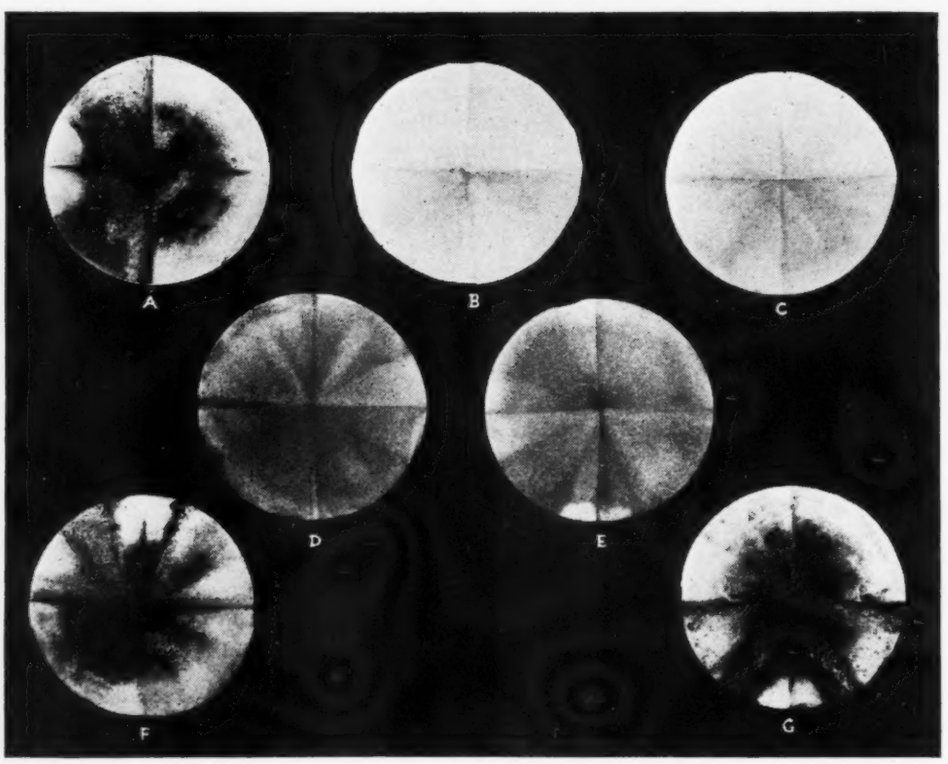
In the past few months, the authors have investigated the possibility of increasing the percentage light translucency of oils lacking in stability of light translucency above a temperature of 250 deg. cent., such as of naphthene base oils. At the same time, it was deemed advisable to

Comparison of chemical decomposition of various used oils in terms of carbon.

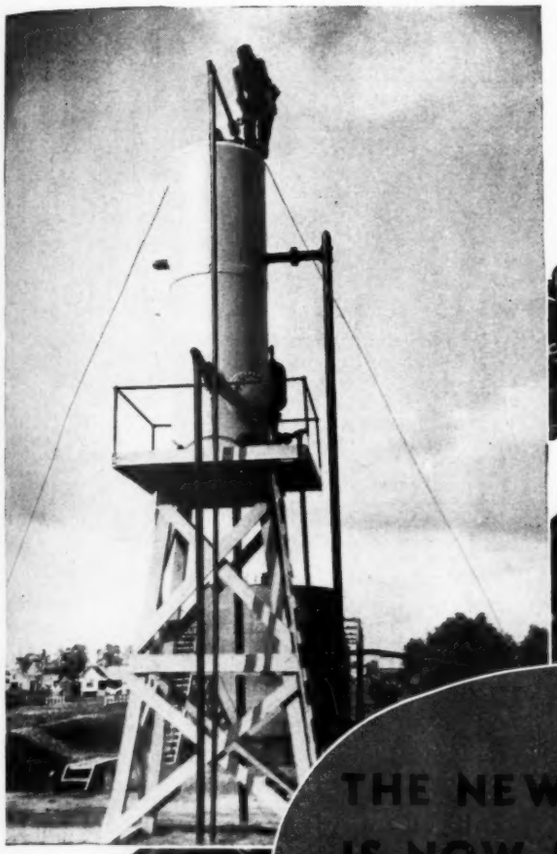
Fig. 9a (right)—Residue after ether wash.

Fig. 9b (below)—Residue after wash with xylene, chloroform, acetone, and carbon bi-sulphide —subsequent to ether wash.

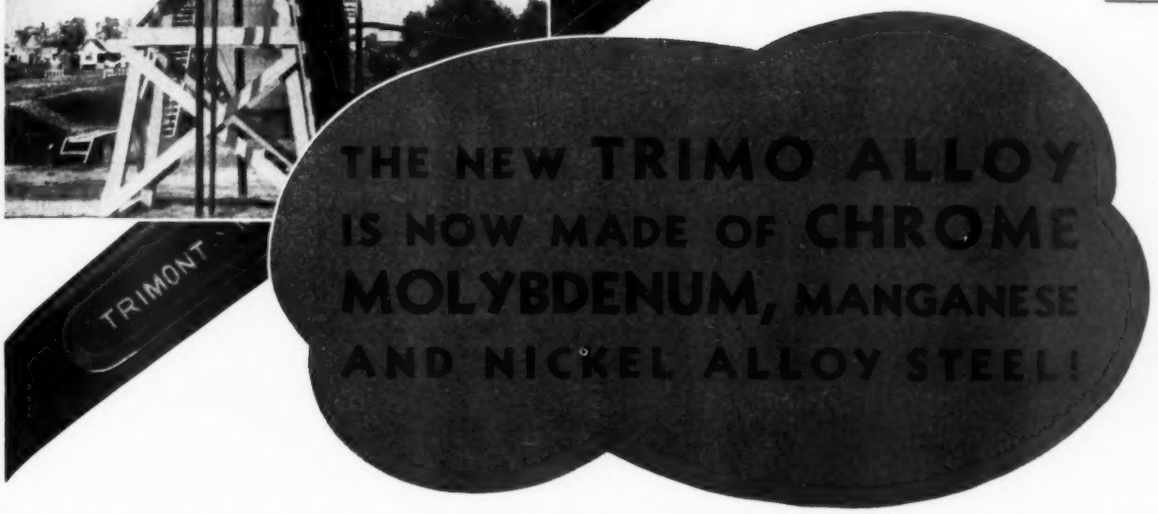




NO MORE NEED TO GAMBLE
ON PIPE WRENCH STRENGTH



Look for the red tag wired to the handle.



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investigate the possibility of rejuvenating the percentage light translucency of used oils.

Two processes have been employed for the rejuvenation and increase of the percentage light translucency of oils, the nature of these processes not being divulged at the present time. These processes are termed Process No. 1 and Process No. 2.

Procedure: The oils investigated were treated by either Process No. 1 or Process No. 2, or both, and the percentage light translucency values were determined before and after treatment and the results compared. A study of the decomposition of the percentage light translucency of treated and untreated oils was then made. The results are given in Table VI and represented in Fig. 10.

TABLE NO. VI

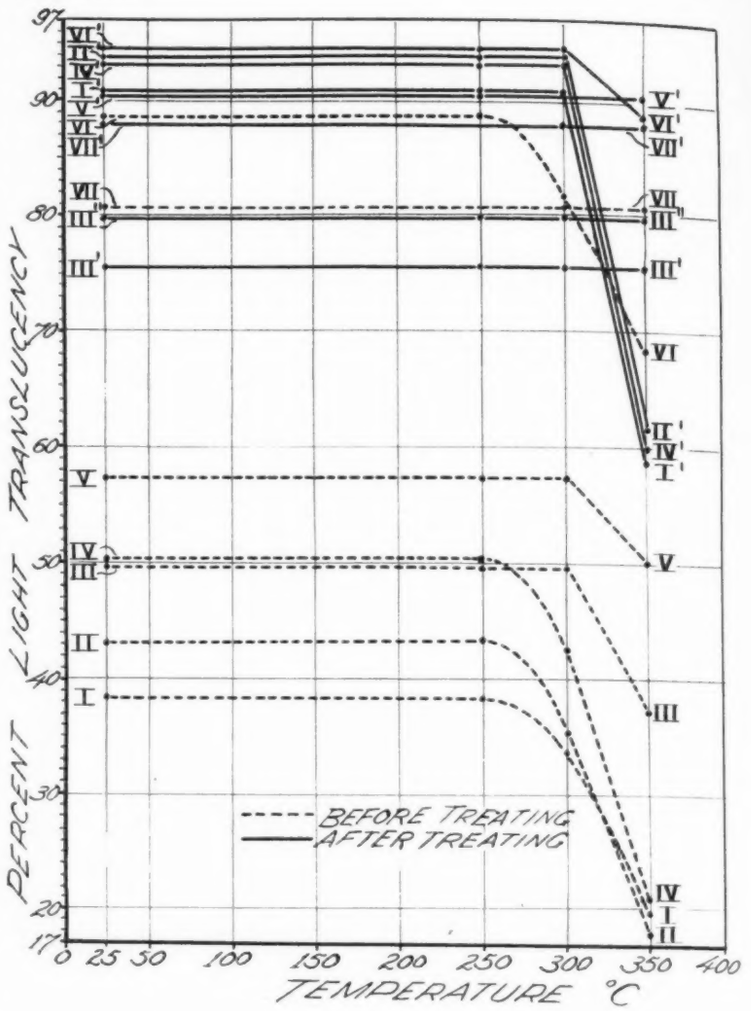
Sample by Ref. No. from Table I	Curve No.	Process Used	Percentage Light Translucency		
			Initial to 250° C.	300° C.	350° C.
28	I	Initial	38.17	33.61	19.72
	I′	1	90.60	90.60	58.70
2	II	Initial	43.15	35.24	17.74
	II′	1	93.81	93.81	61.54
WHITE OIL (Western Naphth. Base)	III	Initial	49.78	49.78	37.01
	III′	1	79.90	79.90	79.90
	III″	2	75.49	75.49	75.49
4	IV	Initial	50.49	42.54	20.81
	IV′	2	93.17	93.17	60.11
29	V	Initial	57.18	57.18	50.18
	V′	1	90.35	90.35	90.35
40	VI	Initial	88.48	81.69	68.27
	VI′	1	94.53	94.53	88.48
41	VII	Initial	80.67	80.67	80.67
	VII′	1	87.74	87.74	87.74

Observations: 1. All naphthene base oils show a marked increase in durability corresponding to an increase in percentage light translucency brought about by processing. See Fig. 10, Table VI.

2. Even for Pennsylvania, paraffin base oils, an increase of the percentage light translucency is shown. See curves VII and VII′, Fig. 10.

3. Mid-Continent base oils also appear amenable to an increase in percentage light translucency and an increased stabilization of same by the application of the Special Processes No. 1 and No. 2.

Fig. 10—Decomposition curves showing the effect of special processing upon the stability and value of percentage light translucency for various oils.



In the next article the authors will cite the work being done at the present time and results so far obtained; and, at the same time give literature appertaining to the definition of "oiliness" in order that the final conclusions to this series of articles may be set forth with the greatest emphasis.

Instruments—The Entering Wedge

By F. L. KALLAM

WHERE a plant is obsolete and adequate appropriations for modernization are refused, the engineer faces a difficult problem. In most cases he can be sure on general principles that the plant is losing heavily; to demonstrate that loss to the management is another matter. Instruments may end his troubles. While the task of getting money enough for complete modernization appears hopeless, he may be able to procure a smaller appropriation. The question arises whether this money should be used to modernize a portion of the plant, or whether to spend it for control instruments. To some, the latter course might seem like that of the man who spent his last dollar for a pocketbook. Why spend money for meters to record the exact performance of a plant where obviously that performance is far below standard? First, the instruments can give the operating results of the plant "as is." A well-presented comparison of the results recorded with those obtained in modern plants will set the main office thinking. Next, with the aid of recording instruments, a substantial improvement can generally be made in the operation of existing equipment, and be demonstrated to the management. Next, the best type of equipment and layout for the complete modernization of the plant is determined. Prices and guarantees of performance can be obtained that, when compared with present performance shown by the instruments, will quickly show the main office what the improvements will mean from the point of view of dividends. Having built up confidence, the engineer will be in a fair way to obtain the appropriation for a modernized plant. And, finally, when the plant is modernized, the instruments are not wasted. They can easily be shifted and reapplied to the new equipment, where they will demonstrate to the engineer and to the management the savings he had predicted.

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Petroleum Production

Article II

EQUIPMENT AND OPERATION OF OIL WELLS (Continued)

By K. C. SCLATER

IN the first article of this series it was shown that all types of oil wells may be divided into two classes:

1. Naturally flowing wells.
2. Wells produced by mechanical means.

These may then be subdivided into groups according to the method by which they are made to produce.

Under Class 1, naturally flowing wells were divided into two groups:

1. Wells flowing through casing.
2. Wells flowing through tubing.

Under Class 2, wells produced by mechanical means were divided into four groups; wells produced by:

1. Swabbing and bailing.
2. Gas-lift.
3. Reciprocating oil well pumps.
4. Special types of pumps.

Thus far we have discussed the equipment and operation of: 1, naturally flowing wells; 2, swabbing and bailing wells; and 3, gas-lift wells. The equipment and operation of an important group still remains to be discussed—that of pumping wells.

Pumping Wells

It was noted in Article 2 that the three most important groups of wells are: 1, naturally flowing wells; 2, gas-lift wells; and 3, pumping wells. Of these, it is estimated that group 3, pumping wells, comprises between 80 and 85 per cent of the total oil wells producing today. In this group are included, in the United States alone, some 250,000 stripper wells having an average oil production of one bbl. a day.

Pumping wells may be conveniently divided into two groups. Wells produced by:

1. Reciprocating oil well pumps actuated by sucker rods or wire line.
2. Special types of pumps not requiring sucker rods.

Almost all pumping wells fall into the first group, which includes all types of wells produced by beam-pumping, jack-pumping, and individual power pumping units. This is the oldest method of producing oil wells and the method by far the most widely used today.

Reciprocating Oil Well Pumps. Although almost all reciprocating oil well plunger pumps actuated by sucker rods operate on the same principle, they vary in the details of design. In recent years, however, the adoption by the industry of A.P.I. standards has done much toward simplifying and improving the general design of standard oil well pumps. These standards also make for a remarkable degree of uniformity that greatly simplifies the field man's problems.

The standard type of oil well reciprocating plunger pump consists of three essential parts: 1, the working barrel, which is the cylinder in which the plunger works; 2, the plunger, which is usually of steel and is hollow; and 3, the valves, of which there are two, a lower or standing valve, and an upper or traveling valve. Ball valves are standard, but other types are also in use. Sometimes instead of a steel or metal plunger, only a set of cups mounted on a hollow steel body is used with the traveling valve, in which case, the field man, if asked, would likely say the well was being pumped by a "common working barrel," a term in popular usage in the field for a pump with a cup-packed plunger.

An oil well pump operates similar to any ordinary single-acting horizontal reciprocating pump, except that the fluid pumped passes through the plunger, which is hollow. In the standard type of pump the traveling valve is attached to the upper end of the plunger. The standing valve, when in position, is seated in the lower end of the working barrel. The lower end of the string of sucker rods is screwed to the top of the cage of the standing valve.

When the pump is on its upstroke, the standing valve, which opens upward, is opened by the pressure of the fluid from below, while the traveling valve, which also opens upward, is held on its seat by the pressure of the fluid from above and oil is thereby drawn into the working barrel. On the downstroke, the standing valve is forced down on its seat by the fluid pressure from above and the traveling valve is lifted off its seat by the fluid pressure from below, and the oil in the working barrel is forced through the hole in the center of the plunger and up past the traveling valve, to be carried up inside the tubing to the surface with each upstroke of the pump. Each valve works in a cage that limits its lift to the proper amount.

Specifications prepared by the A.P.I. Standardization Committee on pumping equipment designate four sizes of working barrels as standard. These are 2-in., 2½-in., 3-in., and 4-in., and are obtainable in lengths of 5, 6, 7, 9, 11, 15, and 20 feet. It is to be noted that pump sizes are nominal and that the inside diameter of the working barrel, which determines the cross-sectional area of the pump, is ¼ in. less than the nominal size of the pump. The inside diameter of the working barrel of a 2-in. pump, for example, is only

1¾ inches; of a 2½-in. pump, 2¼ inches; of a 3-in. pump, 2¾ inches; and of a 4-in. pump, 3¾ inches.

Working barrels of oil pumps employed in modern field practice are usually of cold drawn steel tube and are smoothly finished to within the tolerances given in A.P.I. specifications.

Another type of working barrel in use in the older and shallower fields is known as the old "Eastern" type. It is made of cast iron and is reamed inside to a smooth finish. It is well adapted for pumping shallow wells of small daily production and where gritty material, such as fine sand or salt, is absent.

Working barrels are also made with liners, of which there are two general types. One type has a steel outer tube into which is fitted a precision-machined liner of cast iron. The liner is made up of a series of short sections, an arrangement that permits machining and finishing the plunger and liner to a very close fit, even in pumps from 9 to 20 ft. in length. The other type of liner is a solid tube, machined and polished inside to within the close tolerances set by A.P.I. standards. Pumps in which liners are used are commonly known as liner barrel, or liner type, plunger pumps.

To cope with special well troubles, such as corrosion, for example, working barrels of brass, wrought iron, or special steel alloy are sometimes employed. Some fields are notorious for the troubles encountered in wells by corrosion. Cup-packed plungers rather than metal plungers are employed in brass working barrels or working barrels made from the softer metals.

Steel plungers may be used alone or in combination with cups, and with either one or two sets of cups. The cups are of leather or of composition material. Two or more cups comprise a set. When used with a metal plunger a set of cups is mounted on the top, or the bottom, or on both ends of the plunger, depending on the conditions encountered in the well. They may even be mounted between sections of the plunger.

As might be expected, the need for close tolerances is greatest in pumps equipped with steel or metal plungers. Cups, being flexible, readily adjust themselves to the inside surface of the working barrel; hence, when only a cup-packed plunger is used, a wide variance in tolerance is permissible. So long as the inside of the working barrel is smooth the pump will operate satisfactorily. The use of the cup-packed type of plunger is adapted to pumping shallow wells that produce small quantities of sand with the oil.

Plungers in the standard reciprocating type of oil well pumps, as will be gathered from the foregoing discussion, may be of the cup-packed type, of steel or metal, or a combination of the two.

In placing a standard pump in the well, the working barrel is run on the tubing, and the plunger and standing valve on the sucker rods. If the working barrel becomes worn or requires repairs it entails pulling the tubing, as well as the rods. This is not a very serious matter in shallow wells, but in deep wells it is a source of great expense. By pulling the string of sucker rods, the traveling valve and the plunger can be brought to the surface. If the pump has a "garbutt rod" attachment, the standing valve is brought to the surface also with the plunger and traveling valve. If the pump does not have a "garbutt rod" or similar attachment and the standing valve is removable, which it usually is in modern deep-well pumping practice, the standing valve may be recovered by a special tool run on the sand line. But should the pump barrel have to be replaced or brought to the surface for examination or repairs it becomes necessary to pull both the string of rods and the string of tubing. This difficulty has been overcome by the use of inserted pumps, which are so designed that the entire pump assembly can be run in or removed from the well on the string of sucker rods.

Inserted pumps are now widely used in well-pumping operations. Tentative standards on inserted pumps have been prepared by the Standardization Committee of the A.P.I. on pumping equipment. Three nominal sizes have been approved, namely, 2-in., 2½-in., and 3-in., regarding which it is important to note that the plunger diameter of the 2-in. inserted pump is $1\frac{1}{16}$ in.; of the 2½-in. size, 1½ in.; and of the 3-in. size, 1¾ inches.

Another type of reciprocating pump developed for use in oil wells is the fluid-packed pump. The distinctive feature of this pump is that it operates with a clearance of about ten thousandths (.010) of an inch and depends for its packing effect on the friction of the fluid through this annular clearance, which, due to the ingenious construction of the pump, actually extends a distance of twice the length of the pump. This is the distance the slippage oil must travel before it escapes from the pump. There are three concentric tubes, two of which are traveling tubes rigidly attached to each other, and the other a standing tube that forms the stationary part of the pump. When the pump is in operation the traveling tubes telescope the standing tube, one on the outside and the other on the inside. Thus the two traveling tubes function as a loose-fitting plunger, but with a much smaller slippage than that of a loose-fitting plunger of the conventional type. The plunger, which, as explained, consists of the two traveling tubes, has two traveling valves, an upper and a lower. On an extension below the lower traveling valve there is a device for pulling out the standing valve, which is held securely in the base of pump by means of an expanding mandrel locking shoe while the pump is in operation. The design of this pump makes it especially adapted to pumping heavy oil, heavy emulsions, or a well producing large quantities of sand with the oil.

QUESTIONS

1. What are the essential parts comprising a standard reciprocating oil well plunger pump?
2. Describe the operating cycle of an oil well plunger pump.
3. Describe two types of liner working barrels.
4. By what amount does the diameter of the plunger differ from the nominal size in the standard sizes of plunger pumps? In the standard sizes of inserted pumps?
5. What advantage distinguishes an inserted pump from a regular plunger pump?

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Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XI

USE AND SPECIFICATIONS OF PRODUCTS—(Continued)

BLENDING OF INTERMEDIATE STOCKS

THE products from the primary distillation and refining operations are usually intermediate stocks that must be blended or compounded in preparing finished market products. In the case of gasoline, the material that is sold at the filling station may consist of a blend of four intermediate stocks. The stocks that may be blended together are: natural gasoline, straight-run gasoline, cracked gasoline and straight-run naphtha.

The many lubricating oils that are sold are generally compounded from four intermediate stocks. These stocks are: non-viscous neutral oil, light neutral oil, viscous neutral oil, and bright-stock. All these stocks are not used in every lubricating oil, and for some special oils other intermediate stocks may be required.

The methods that are outlined herein for the determination of the properties of blends are for estimating purposes. That is, they will serve as a guide in the blending operations and they will aid in making cost estimates of the value of various blended stocks. The actual blends are always tested in the laboratory to determine the exact properties before they are sold.

BLENDING OF GASOLINE. The main purpose of blending gasoline from the several intermediate stocks is to be able to make many kinds of finished gasoline without changing the general operation of the refinery. With the four above-mentioned stocks it is possible to adjust the vapor-pressure between four and ten lb. per sq. in.; to adjust the octane number from 50 to 75; to adjust the end-point between 380 and 430 deg. fahr.; and to adjust the intermediate distillation points such as the 10, 50, and 90 per cent points.

Natural gasoline, straight-run gasoline, and cracked gasoline are used by almost all refiners but the use of blending naphtha is not extensive. In some cases it pays to produce a naphtha cut so that low end-point gasoline and the naphtha can be chemically treated separately at a lower cost. The naphtha is sometimes separated so that it can be reformed into higher octane number gasoline or for the production of special solvent products. Most plants have a market for two gasolines of different end-point, but the low end-point gasoline is the major product. It is often convenient to operate the plant for the production of the low end-point gasoline and to prepare the other gasoline by using blending naphtha.

Octane Number. The octane number of a blended gasoline is almost directly proportional to the octane numbers of the blending stocks. As an example, if 50 parts of a 70-octane stock is blended with 50 parts of a 50-octane stock the resultant 100 parts of mixture has an octane number of 60. A more complex example follows:

Example 1. Octane Number of Blended Gasoline.

A gasoline is to be produced by mixing 49 per cent of straight-run gasoline, 12 per cent of natural gasoline and 39 per cent of cracked gasoline. The octane numbers of these materials are:

	Octane Number
Straight-run gasoline	51
Natural gasoline	61
Cracked gasoline	79

What is the octane number of the blend?

Solution.

Straight-run gasoline	$0.49 \times 51 =$	24.99
Natural gasoline	$0.12 \times 61 =$	7.32
Cracked gasoline	$0.39 \times 79 =$	30.81
Octane number of blend		63.

The gravity of a blended oil can be computed in the same way as in Example 1. However, the specific gravity and not the A.P.I. gravity, must be used. The relation between specific gravity and A.P.I. gravity is:

$$\text{Degrees A.P.I.} = \frac{141.5}{\text{Sp. Gr.}} - 131.5$$

Example 2. Specific Gravity and A.P.I. Gravity.

The A.P.I. of an oil is 36.5.

What is the specific gravity?

Solution.

$$36.5 = \frac{141.5}{\text{Sp. Gr.}} - 131.5$$

$$36.5 \times 131.5 = \frac{141.5}{\text{Sp. Gr.}} = 168$$

$$\text{Sp. Gr.} = \frac{141.5}{168} = 0.842$$

Example 3. Gravity of Gasoline Blend.

1000 gal. of 0.77-gravity naphtha is to be mixed with 2000 gal. of 0.74-gravity gasoline.

What is the specific gravity of the blend?

Solution.

$$\begin{array}{rr} 1000 \times 0.77 = & 770 \\ 2000 \times 0.74 = & 1480 \\ \hline 3000 & 2250 \end{array}$$

$$\text{Sp. Gr.} = \frac{2250}{3000} = 0.75$$

Corresponding A.P.I. is about 57.5.

Vapor Pressure. The vapor pressure that is obtained when natural gasoline is mixed with another gasoline is important. The natural gasoline has a relatively high vapor

*Professor of Petroleum Refining, University of Tulsa.

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pressure and the addition of too much of it will increase the vapor pressure of the blend so greatly that it does not meet market specifications. The vapor pressure of a blend can be computed in a manner similar to that used in Example 1 except that molecular or mol percentages, rather than volume percentages, must be used. The mol percentage is computed by determining the pound mols of each stock that is used in the blend and dividing by the total number of mols of material, thus:

Example 4. Computation of Mol Percentage.

A blended gasoline consists of 550 lb. of straight-run gasoline, 290 lb. of cracked gasoline, and 160 lb. of natural gasoline. The approximate molecular weights of these stocks are:

Straight-run gasoline	110
Cracked gasoline	115
Natural gasoline	80

Express the composition of the blend as mol percentage.

Solution.

The molecular weights that are given in the statement of the example were determined by the use of charts. These charts will be published in a subsequent article.

Mols of S. R. gasoline	$\frac{550}{110}$	$= 5.5$
Mols of cracked gasoline	$\frac{290}{115}$	$= 2.52$
Mols of natural gasoline	$\frac{160}{80}$	$= 2.0$
Total mols of gasoline		$= 10.02$
Mol percentage of S. R. gasoline	$\frac{5.5}{10.02} \times 100$	$= 54.89$
Mol percentage of cr. gasoline	$\frac{2.52}{10.02} \times 100$	$= 25.15$
Mol percentage of nat. gasoline		$= 19.96$
		$100.$

Having determined the mol percentage (Example 4), the computation of the vapor pressure of the blend is a simple problem. The vapor pressure of the blend is directly proportional to the amount of each stock used in the blend and to the vapor pressure of each of the stocks.

Example 5. Computation of the Vapor Pressure of Blended Gasoline.

(A) A gasoline is to be blended as follows:

	Mol per cent	Vapor Pressure lb./sq. in
Straight-run gasoline	56	4
Cracked gasoline	28	5
Natural gasoline	16	18

What is the vapor pressure of the mixture?

Solution.

S. R. gasoline	0.56×4	$= 2.24$
Cracked gasoline	0.28×5	$= 1.40$
Natural gasoline	0.16×18	$= 2.88$
Vapor pressure of blended gaso.		6.52

(B) The vapor pressure of commercial gasoline is usually limited to about eight lb. per sq. in.

What mol percentage of the following two stocks should be used to make an 8-lb. gasoline?

Natural gasoline	22 lb. vapor pressure
Straight run gasoline	5 lb. vapor pressure

Solution.

Let x = the mol percentage of natural gasoline in the final blend.

Then the rest of the percentage or (100-x) is the percentage of straight-run gasoline.

As in (A) part of this example:

Natural gasoline	$22x$	$= 22x$
Straight-run gasoline	$5(100-x)$	$= -5x + 500$
Blend	$8(100)$	$= 17 + 500$

$x = 17.7$ mol per cent natural gasoline.

$(100-x) = 82.3$ mol per cent straight-run gasoline.

The Reid vapor pressure can be used with fair accuracy in these calculations (Example 5), but if exact results are required then the true vapor pressure must be used. In general, the true vapor pressure is a little higher than the Reid vapor pressure.

Boiling Range. The boiling range of a blend cannot be determined in the direct way that was used in the above examples. The initial-boiling-point and the end-point cannot be predetermined with accuracy, but the intermediate boiling points can be estimated with some success. The following example will illustrate the method of computation more clearly than any amount of discussion could do.

Example 6. Estimation of Boiling Range of Gasoline Blend.

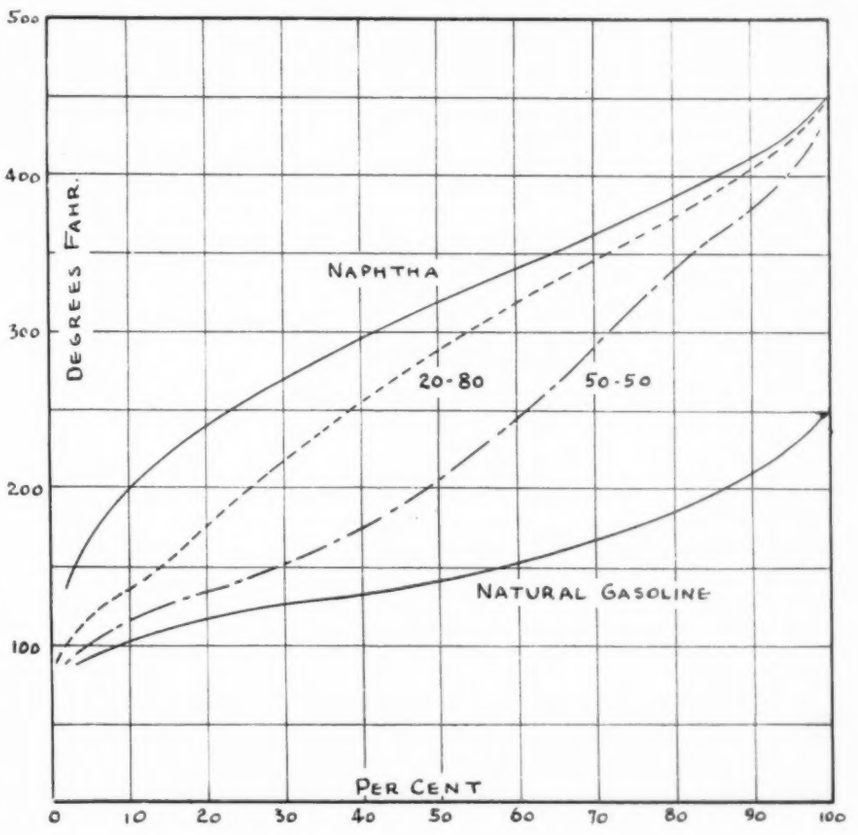

Fig. 24. Boiling range of blended gasolines

The following straight-run naphtha and natural gasoline are to be blended:

	Naphtha	Natural Gaso.
IBP	136 deg. fahr.	90 deg. fahr.
5	181	100
10	210	109
20	247	122
50	324	145
70	366	173
90	417	222
95	435	240
E.P.	450	252
Loss	2 per cent	4 per cent

These distillations are plotted in Fig. 24. The loss is plotted at the front of the distillation curve. What will the approximate boiling range be if the blend contains 20 per cent natural gasoline? Will the blend have a satisfactory boiling range?

Solution:

The average of the two distillations will be computed using temperature as the basis.

Basis: Temperature
80 cc. naphtha
20 cc. of natural gasoline

The cc. of material boiling to 150 deg. fahr. will be:

From natural gasoline	$.58 \times 20 =$	11.6 cc.
From naphtha	$.03 \times 80 =$	2.4 cc.
Total		14.0 cc

Since the total amount of mixture is 100 cc. the material to 150 deg. fahr. is 14.0 per cent. The following tabulation was computed in a similar manner:

Temperature	Per cent of Materials in Naphtha	Per cent of Materials in Nat. Gaso.	Cc. from Naphtha	Cc. from Nat. Gaso.	Total cc. or Percentage
90	....	4	0	0.8	0.8
100	....	9	0	1.8	1.8
120	1	23	0.8	4.6	5.4
150	3	58	2.4	11.6	14.0
175	6	75	4.8	15.0	19.8
200	10	87	8.0	17.4	25.4
225	16	95	12.8	19.0	31.8
250	23	....	18.4	20.0	38.4
300	41.8	....	33.5	20.0	53.5
350	64.3	....	51.5	20.0	71.5
400	85.8	....	68.7	20.0	88.7
425	94.7	....	75.7	20.0	95.7

The distillation of the blend is plotted in Fig. 24 and marked 20-80. The distillation curve is not satisfactory because the 50 and 90 per cent points are too high and the end-point is still high.

The curve marked 50-50 (Fig. 24) was computed for a half and half mixture of the two stocks. It is a better distillation curve (although it is not a normal one) and the product probably could be sold without trouble. The end-point will probably not exceed 437 deg. fahrenheit.

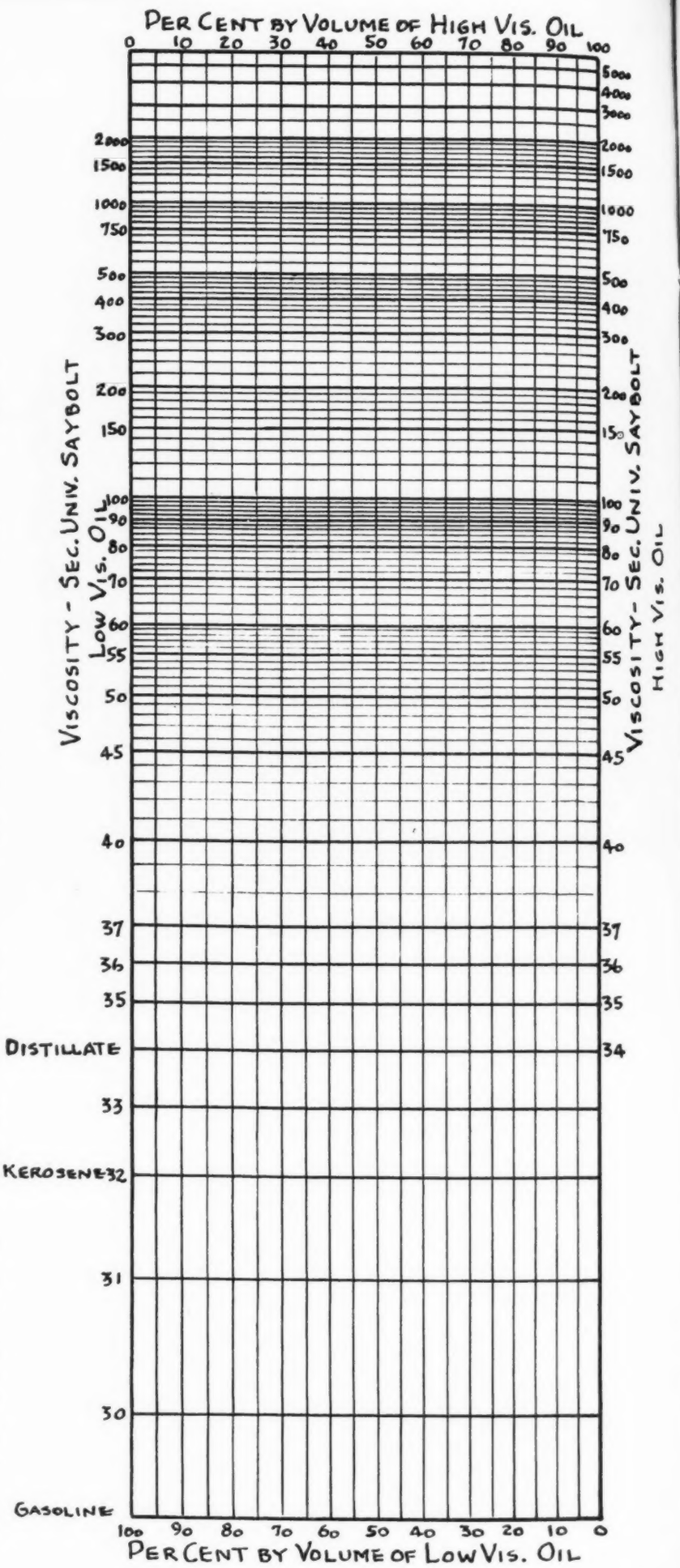

Fig. 25—Viscosity blending chart

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LUBRICATING OIL BLENDS. In compounding lubricating oils the viscosity of the blend is usually the only property that is considered. The flash-point also would be of interest but there is no simple way to compute the flash-point of a compounded oil from the flash-points of the stocks.

Viscosity of Blend. Gravity and octane number, as discussed previously in Examples 1 and 3, are additive properties. That is, the property of a 50-50 mixture is the arithmetic average of the properties of the two stocks. Viscosity is not an additive property. As an example, if 50 parts of a 100 viscosity oil is mixed with 50 parts of a 300 viscosity oil, the resultant mixture does not have a viscosity of 200. The viscosity will be lower and by the A.S.T.M. type chart, Fig. 25, the viscosity will be about 168. Apparently, the low viscosity material tends to lubricate the high viscosity material so that the mixture flows more easily than the arithmetic average indicates.

In the past, many charts have been suggested for determining the viscosity of blends. These charts have been examined by the American Society for Testing Materials and after conducting additional experiments the A.S.T.M. is promoting the use of Fig. 25[1] as a general method of computing the viscosity of blends. The chart is adequate for the purposes for which it was constructed but it is not uniformly accurate when used for different bases of oils or for oils of widely differing viscosity index. Charts of this nature, for blending oils of different bases, have been published by O. G. Wilson.[2]

Fig. 25 is an extension of the chart that is proposed by the A.S.T.M. It was published by Larson and Schwaderer.[3] The use of the chart is illustrated in the following example:

Example 7. Viscosity of Lubricating Oil Blend.

(A) A lubricating oil having a viscosity of 140 Saybolt seconds at 100 deg. fahr. is to be mixed with an equal amount of an oil whose viscosity is 380 seconds at 100 deg. fahrenheit.

What is the viscosity of the blend?

Solution.

The low viscosity oil is located on the left axis of Fig. 25 and the high viscosity oil on the right axis. A straight line is drawn between these points.

The viscosity of the blend is read at 50 per cent on the horizontal axis.

The viscosity is about 227 Saybolt seconds at 100 deg. fahrenheit.

The viscosities of the two stocks must be given at the same temperature. That is, the viscosities should both be given at 100 deg. or at 210 deg., not one viscosity at 100 deg. and the other at 210 degrees.

(B) 90 per cent of a 380-viscosity oil is to be blended with 10 per cent of a 220-viscosity oil.

What is the viscosity of the blend?

Answer. 360 viscosity.

(C) It is desired to produce a 350-viscosity oil from two stocks whose viscosities are 450 and 300.

How much of the 450 stock should be used?

Solution.

Locate 450 on the right scale and 300 on the left.

Draw a line between these points.

Run down the line to 350 viscosity and read the percentage.

Answer. About 35 per cent of the high viscosity stock.

Summary. The computations that are outlined in this paper are not of great value in plant work. In the plant, the exact properties that will result upon blending are usually known because of a long experience in making blends. Nevertheless, the student of petroleum refining can get a broad insight into the details of refinery operation by studying the properties of blends.

QUESTIONS

1. What is the octane number of a 50-50 blend of a 50 octane stock and a 75 octane stock?
   Ans. 62.5.
2. What is the octane number of a 90-10 blend of a 60 octane stock (10 per cent) and a 70 octane stock?
   Ans. 69.
3. What is the specific gravity of a 75-25 mixture of 0.8 and 0.84 gravity stocks?
   Ans. 0.81.
4. What is the viscosity of a blend that consists of 70 per cent of a 400 viscosity oil and 30 per cent of a 250 viscosity oil?
   Ans. 343.

REFERENCES

[1]Tentative Standard of A.S.T.M. D341-32T.

[2]"Chart Method of Predicting Viscosity," *National Petroleum News*, p. 87, May 22, 1929.

[3]*Oil and Gas Journal*, p. 10, June 21, 1934.

[4]Smith, "Blending Value of Natural Gasoline," *National Petroleum News*, June 4, 1930.

[5]Zublin, "Blending Value of Natural Gasoline," *Refiner and Natural Gasoline Manufacturer*, p. 107, June, 1930.

Black Gold Refining Company Takes Out a Dubbs License

The Black Gold Refining Company has just taken a license to operate the Dubbs cracking process in its refinery at Oklahoma City.

Two years ago, Black Gold installed a non-licensed cracking unit of about 700 barrels capacity. It was completed in 1932.

On May 11, 1933, Universal Oil Products Company sued the Black Gold, a Delaware corporation, in the federal court in Wilmington, Del., seeking damages and charging that operation of Black Gold's cracking equipment infringed two patents owned by Universal.

These patents are No. 1,392,629, known as the clean circulation patent, and No. 1,890,974. Both patents were issued to Carbon Dubbs and assigned to Universal.

The first named is one of the patents that was found valid by Federal Judge John P. Nields in the suit brought by Universal against the Root Refining Company. Judge Nields held it infringed by the Root company.

It is understood that the conditions of the settlement were: (1) Black Gold in the future to operate under license from Universal; (2) Black Gold to pay in full the accrued royalties for past operations from the start of its cracking plant; (3) Universal to dismiss its pending infringement suit against Black Gold.

Remodeling of the Black Gold unit to operate in accordance with the most efficient Dubbs practice will start immediately.

Elements of Applied Petroleum Pipe Line Transportation

Article 2

THE FLOW OF OIL IN PIPES AND PIPE LINES

Part 2—Application of Reynolds Number to the Solution of Flow Problems

By

EMORY KEMLER[1]

and

L. L. THOMAS[2]

THE formula given for pressure drop calculations is not in its most convenient form as the diameters are usually given in inches, the pressure as lb./in.^{2}, etc. If we use:

Δp = pressure drop in lb./in.^{2}
l = length of pipe in feet
g = 32.2
d = pipe diameter in inches
v = mean velocity in ft./sec.
V = rate of flow in ft.^{3}/sec.
Q = gal./min.
W = rate of flow in lb./sec.
B = bbl./hr. (42 gallons)
μ = absolute viscosity = lb./ft. $\times$ sec.
ν = kinematic viscosity = ft.^{2}/sec.
ρ = density in lb./ft.^{3}
f = friction factor

The flow equations then reduce to:

$$\Delta p = \frac{.00129\, f\, l\, v^2\, \rho}{d} = 43.76\, \frac{f\, l\, V^2\, \rho}{d^5}$$

$$= 43.76\, \frac{f\, l\, W^2}{d^5 \rho} = .000217\, \frac{f\, l\, Q^2\, \rho}{d^5}$$

$$= .0001063 \frac{f\, l\, B^2\, \rho}{d^5}$$

And Reynolds number becomes:

$$R = \frac{Dv\rho}{\mu} = .0833\, \frac{dv\rho}{\mu} = 15.3\, \frac{V\rho}{d\mu} = 15.3\, \frac{W}{d\mu}$$

$$= .0342\, \frac{Q\rho}{d\mu}$$

$$R = .0833\, \frac{dv}{\nu} = 15.3\, \frac{V}{d\nu} = 15.3\, \frac{W}{d\rho\nu}$$

$$= .0342\, \frac{Q}{d\nu} = \frac{.0237\, B}{d\nu}$$

In order to use Reynolds number method of analysis it is necessary to have the viscosity of the fluid. This viscosity may be known in any of several forms. For fluids other than oils the absolute viscosity is frequently given in cm.-gm.-sec. units as poises or the kinematic viscosity as stokes, particularly if they are given in chemical references. In mechanical work where the ft.-lb.-sec. units are used, it is more convenient to use these units for expressing viscosity. For oils the viscosity is usually given as Saybolt seconds, which is the time for a certain amount of oil to flow through a given-sized capillary tube at a particular temperature. It is, therefore, convenient to have some method of converting from one system of units to the other.

For converting from cm.-gm.-sec. units to ft.-lb.-sec. units we have the following relation:

Kinematic viscosity in ft.-lb.-sec. units = kinematic viscosity in cm.-gm.-sec. units (stokes), (1 stoke = 100 centistokes) $\times$ .0672.

Absolute viscosity in ft.-lb.-sec. units = absolute viscosity in cm.-gm.-sec. units (poises), (1 poise = 100 centipoises) $\times$ .0672.

Absolute viscosity in ft.-lb.-sec. units = kinematic viscosity in cm.-gm.-sec. units (stokes) $\times$ specific gravity $\times$ .0672.

For the conversion from Saybolt seconds to ft.-lb.-sec. units or cm.-gm.-sec. units, conversion charts must be used, as there is not a linear relation between these factors. Fig. 4 shows a standard A.S.T.M. temperature-viscosity chart that is commonly used for plotting viscosity curves. This chart is very convenient, since over quite a wide range the temperature-viscosity curve of an oil is a straight line, whereas on ordinary coordinate paper it is a curved line. Since it is a

[1]Engineering Division, Gulf Research and Development Corporation; Assistant Professor of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pennsylvania.
[2]Engineering Division, Gulf Research and Development Corporation.

TABLE 3

Gallons per Minute	Pressure Drop			Power Cost			Fixed Charges			Total Cost		
	1"	1½"	2"	1"	1½"	2"	1"	1½"	2"	1"	1½"	2"
.....	.....	.....	.....	.....	.....	.....	$10.00	16.20	21.65	.....	.....	.....
3	.34	.....	.....	.03	.....	.....	.....	.....	.....	10.03	.....	.....
6	1.05	.16	.....	.21	.03	.....	.....	.....	.....	10.21	16.23	.....
10	2.60	.28	.10	.88	.09	.034	.....	.....	.....	10.38	16.29	21.69
20	10.5	1.35	.39	7.14	.92	.265	.....	.....	.....	17.14	17.12	21.94
40	41.0	4.70	1.35	55.80	6.40	1.83	.....	.....	.....	65.80	22.60	23.48
60	.....	9.60	2.80	.....	19.58	5.72	.....	.....	.....	.....	35.78	27.37

Linde Pioneering

in Welded Pipe Lines

is a Never-Ending Quest

1914—FIRST WORLD'S FAIR to be completely supplied with high pressure gas was the Panama Pacific International Exposition at San Francisco. This gas line, some 15,000 feet of 8-inch steel tubing was oxy-acetylene welded throughout. The wonderful results of this pioneer effort in welding pipe were acclaimed with the greatest enthusiasm.

On the 75th Anniversary of the Oil Industry Linde Leadership Marks Progress with New Achievements

IN THE 75-year history of oil one of the outstanding developments has been the rapid growth of welded pipe lines. Though comparatively young when contrasted to the industry as a whole, this process of joining pipe has made rapid strides since its inception a little over 20 years ago.

Early Projects

Oxwelding of overland pipe lines first attracted the attention of the world in 1914, when it was used for the construction of high pressure gas mains at the Panama Pacific Exposition at San Francisco. Previous to this an 11-mile gas line was laid in 1911, south of Philadelphia.

First Oil Line Welded in 1920

The Prairie Pipe Line Company was first to adopt welding as standard for its lines. This pioneer effort was started with Linde products in December, 1920, with the laying of a 15-mile, 8-inch oil-carrying line from Bartlesville, Okla., to the Cherokee Station, near Ramona, Okla. A little later this company laid the first long welded oil pipe line in the United States, 140 miles from Mexia to Hensley, Texas.

For his original work in connection with these two projects, Mr. N. E. Wagner, Superintendent of Welding for the company, was awarded the Morehead Medal by the International Acetylene Association in 1923.

Original Lines Still in Service

Today, these first oil lines welded by the oxy-acetylene process are still rendering satisfactory service . . . operating almost continuously.

Welding Quickly Spreads

From these early beginnings oxy-acetylene welding and cutting has quickly superseded older methods of laying pipe lines. In 1924, the size of pipe being welded was increased from 8- and 10-inch oil lines to 16- and 18-inch gas lines welded by the Magnolia Gas Company and then to 20-inch by that company and the Lone Star Company in the following year or two. From then on, larger and larger pipe lines were welded up to the 26-inch lines of today. These lines that carry oil, gasoline and gas from the fields to the refining plants or city mains are sometimes over a thousand miles long. They are buried in ditches on land, but frequently they have to be laid across river-bottoms or swamps and in the sea. Needless to say, the thousands of joints in these lines have to be absolutely leakproof otherwise, valuable gas and oil would be lost, and miles of pipes would have to be dug up for repair.

Standard Construction Today

Today, practically every important pipe line is welded. Welding is the proved and accepted method with leading pipe line companies and contractors. They know that once a pipe joint has been welded and tested, it will last as long as the pipe itself. Striking proof of this has been found when terrific floods or earthquakes have torn and broken the pipe itself without as much as cracking the welded joints. Many times welded pipe lines were the only ones not completely torn apart and ruined.

Linde Constantly Fosters Progress

Much of the progress of oxy-acetylene welding and cutting in pipe line construction has been fostered by The Linde Air Products Company. Linde engineers are constantly striving in a never-ending quest for improvement in welding and cutting techniques, materials, rods, gases and equipment.

Develops Speed Lindewelding

Linde developed Lindewelding—a new technique—that doubles or triples the daily production of sound welded joints. It assures stronger pipe joints through a better and faster method of oxy-acetylene welding. It saves 35 to 40 per cent in materials, 30 to 60 per cent in time.

Lindewelder Increases Production

The Lindewelder was another improvement brought out by Linde. This appliance further increases the speed of Lindewelding, and makes the operation almost automatic. Other advances include the Multi-Flame Head for Lindewelding and the Wagner Pipe Cutting Machine for cutting and beveling pipe in the taking up and reclamation of old pipe lines.

Uses of Welding and Cutting Limitless

Oxy-acetylene welding and cutting may be truly termed the process of a thousand uses. In addition to its wide field of application on pipe lines and gathering systems, it is also used extensively for the erection of storage and gasoline plants and in refineries. Typical applications include: heat exchangers, piping of all sizes, vapor lines, condenser lines, structural steel work, absorbers, coils in cooling towers.

Oxwelding and cutting effect large savings in repair work and the salvaging of old equipment and abandoned pipe lines.

The oxy-acetylene blowpipe also is used to hard-face cutter bits and other equipment subject to wear. A coating of wear-resisting metal such as Haynes Stellite, Haystellite Composite Rod, High Strength bronze or High Test steel on the points of wear increases the productive life of parts 2 to 10 times.

March of Progress

Woven into the seventy-five year's history of the petroleum industry is the pioneering work done in the past two decades by the men who typify Linde Process Service. It is a truism that the important advances made in any industry during its continued growth are due as much to the unselfish efforts of men as improvements in materials and processes.

What is Linde Process Service?

Linde men on the firing line exemplify and crystalize a service rendered above and beyond the purchase of tangible goods. They are the direct contact in the field. They work closely with users of Linde Oxygen, assist them in training and qualifying operators and help organize the most efficient welding operations. Yet, this is only the visible evidence of what Linde Process Service means. Linked to the army of service operators are the combined efforts of scientists, engineers and metallurgists constantly working toward improvements in welding technique, materials and apparatus.

Back of the service operators come service supervisors, resident engineers, consulting, development and research engineers. Their work is highly important. Hundreds of practical and theoretical problems in metallurgy and in the application of the oxy-acetylene process for pipe line work are constantly studied by these men. The results of these studies enable Linde service operators to give greater service to Linde customers by bringing to their jobs the latest and best pipe line welding methods.

Linde Cooperation Continuous

Linde has a continuing interest in its customers. It exerts every facility to assure them the highest satisfaction and most profitable use of the Linde products they buy. The nearest Linde Sales Office will be glad to tell you how Linde Process Service can be of help to you. Without cost or obligation, it will gladly furnish complete data to users of Linde Oxygen on welding piping methods. It will make available also such further technical assistance your engineers or construction men may require. Linde Sales Offices are located at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Chicago, Cleveland, Dallas, Denver, Detroit, El Paso, Houston, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Portland, Ore., St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, and Tulsa. Everything for oxy-acetylene welding and cutting—including Linde Oxygen, Prest-O-Lite Acetylene, Union Carbide and Oxweld Apparatus and Supplies—is available from Linde through 126 producing plants and 859 warehouse stocks.

The Linde Air Products Company

Unit of Union Carbide and Carbon Corporation

UCC

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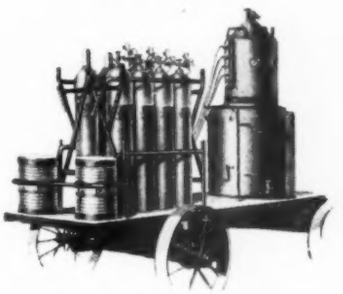
In Canada, Dominion Oxygen Co., Ltd., Toronto

You can order everything for Pipe Line Welding from Linde



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You are cordially invited to visit the welding demonstrations and the numerous other exhibits sponsored by the Corporation in both the Basic and Applied Science sections in the Hall of Science at Chicago's 1934 A Century of Progress Exposition. Here you will see how users of oxy-acetylene welding and cutting, and other products and processes developed by Units of Union Carbide and Carbon Corporation benefit from a most unique coordination of scientific research with manufacturing, sales and service facilities.

· HIGHLIGHTS IN WELDING HISTORY ·

1920—MAKING HISTORY—The last weld being made at Cherokee Station, near Ramona, Okla., on the first oil line to be welded. This 15-mile, 8-inch line is still giving satisfactory service.

1921—FIRST LONG welded oil pipe line in the United States, 140 miles from Mexia to Hensley, Texas. Today, this line is still on the job and many thousands of miles of welded pipe lines cover the country.

1930—NORTH TO SOUTH—On the 24-in. gas pipe line from Amarillo, Texas to Chicago, Ill., oxy-acetylene welding did its part to assure a long-lasting job on such a huge undertaking.

1931—OVER THE MOUNTAINS—On the longest 26-in. gas line, laid over the mountains between Kettleman Hills and Los Angeles, Lindewelding set a record for fast daily production of sound welded joints.

1934—NEW SPEED RECORDS—At the Tulsa Oil Show this Spring, new speed records in welding were chalked up. With the Multi-Flame Lindewelding Head welds were made in 12-in. standard ¼-in wall pipe in 7½ to 8 minutes.

IN ACTION—Out in the field we see the Multi-Flame Lindewelding Head setting new records for fast production on pipe lines. Better, stronger welds in less time, less material and least cost.

straight line on this chart the viscosity need only be obtained at two temperatures and the complete curve can be drawn with sufficient accuracy for most work. On the right-hand side of the chart is shown a conversion scale for converting viscosity in Saybolt seconds to kinematic viscosity in centistokes. On the left-hand side has been added another conversion scale for converting Saybolt seconds to kinematic viscosity in ft.-lb.-sec. units. From these two scales a conversion can be made from ft.-lb.-sec. units to centistokes. These scales then make it easy to make any type of conversion that may be desired without making the cumbersome calculations necessary when using formulas.

Fig. 5 shows some typical viscosity curves taken from the Handbook of Physics and Chemistry and from articles appearing in The Petroleum Engineer and from University of Illinois Engineering Experiment Station Bulletin No. 182 on Flow of Brine in Pipes by R. E. Gould. Viscosities of uncommon fluids can frequently be found in the Handbook of Physics and Chemistry or found by looking up articles listed in "Chemical Abstracts."

Examples.

Several types of flow problems arise depending upon the data known. Examples will be given to show how each is worked out.

1. Assume that it is desired to know the pressure drop in a 2-in. standard pipe, 100 ft. long, carrying 0.1 ft.^{3} of water per sec. at 70 deg. fahrenheit.

The procedure is first to find the Reynolds number, and from the friction factor curves given in Figs. 2 and 3 find f, which is substituted in the formula for pressure drop. From Fig. 5: $\mu = 6.5 \times 10^{-4}$, $\rho = 62.4$ lb./ft.^{3}, $d = 2.07$.

$$R = 15.3 \times \frac{.1 \times 62.4}{2.07 \times 6.5 \times 10^{-4}} = 71{,}000 = 7.1 \times 10^4$$

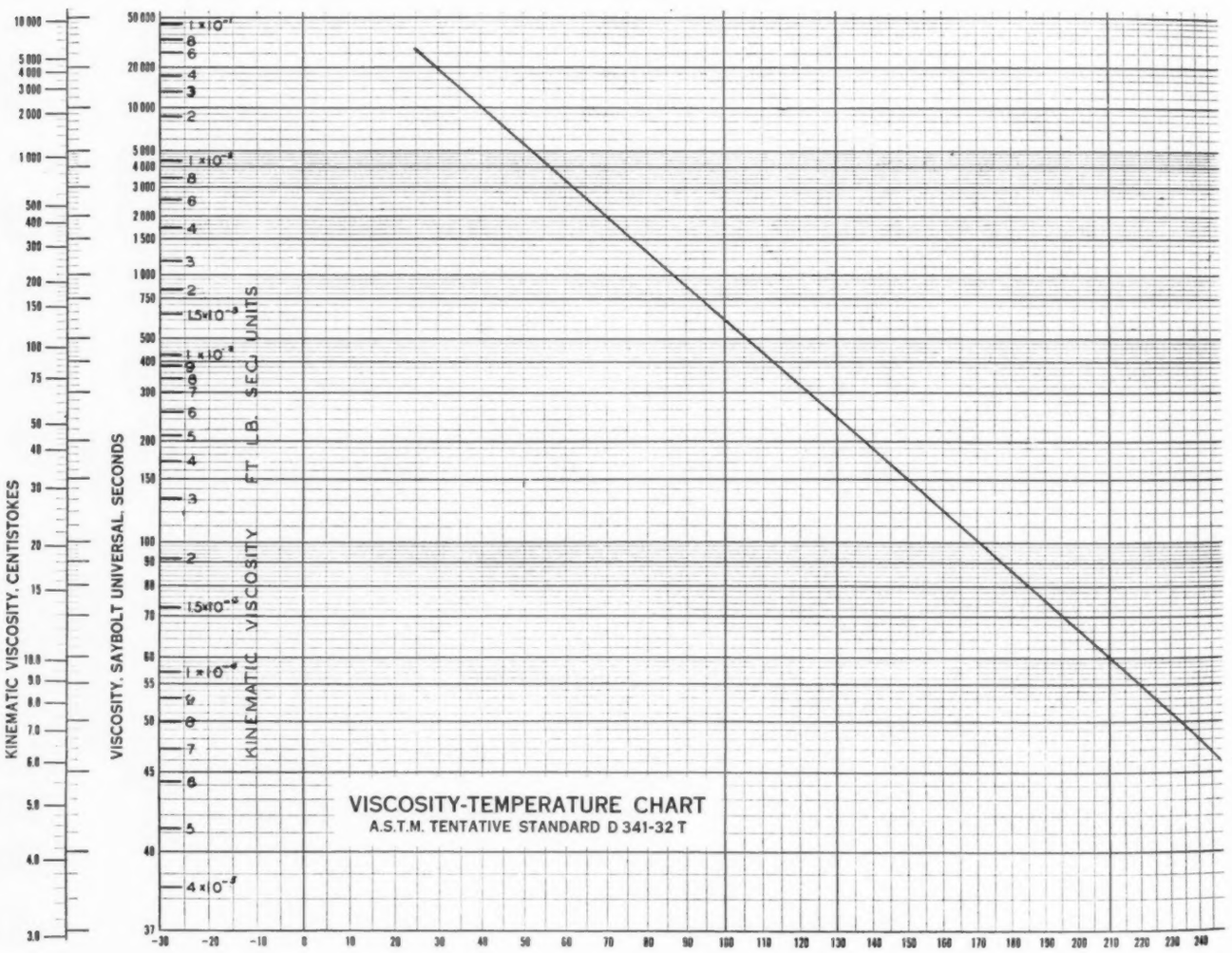
From Fig. 2: $f = .023$.

Then:

$$\Delta p = 43.76 \times \frac{.023 \times 100 \times (.1)^2 \times 62.4}{(2.07)^5} = 1.66 \text{ lb./in.}^2$$

Another type of problem is to find the quantity of fluid that will flow through a given pipe with a certain allowable pressure drop. This type of problem cannot be solved directly since f depends on the volume of flow and cannot be determined until the volume of flow, which is the answer desired, is known. This problem can only be solved by trial and error, unless f be expressed analytically as a function of Reynolds number, which is not practical. It is usually necessary, however, to solve for only two cases as the following example shows:

Fig. 4


KINEMATIC VISCOSITY, CENTISTOKES
VISCOSITY, SAYBOLT UNIVERSAL, SECONDS
KINEMATIC VISCOSITY FT. LB. SEC. UNITS
VISCOSITY-TEMPERATURE CHART
A.S.T.M. TENTATIVE STANDARD D 341-32 T

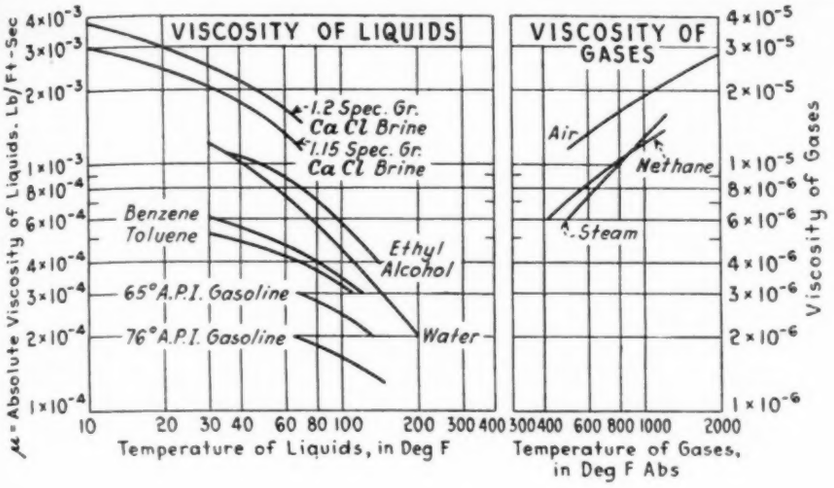


Fig. 5

2. Assume that it is desired to know the flow to give a pressure drop of 5 lb./in.^{2}/100 ft. of 1-in. standard pipe carrying gasoline at 60 deg. fahr. of 56-deg. A.P.I. gravity, which corresponds to a density of 46.8 lb./ft.^{3}.

From Fig. 5: $\mu = 4.3 \times 10^{-4}$, and d = 1.05. If we try Q = 25 gal./min.:

$$R = .034 \times \frac{25 \times 46.8}{1.05 \times 4.3 \times 10^{-4}} = 8.81 \times 10^{4}$$

From Fig. 2 or 3: F = .0255

Then $\Delta p =$

$$\frac{.000217 \times .0255 \times 100 \times (25)^2 \times 46.8}{(1.05)^5} = 12.75 \text{ lb./in.}^2$$

This volume of flow gives too high a pressure drop so that it is necessary to assume a lower rate of flow. If we take 10 gal. per min. we find:

$$R = .034 \times \frac{10 \times 46.8}{1.05 \times 4.3 \times 10^{-4}} = 3.52 \times 10^{4}$$

$f = .028$

Then:

$$\Delta p = .000217 \times \frac{.028 \times 100\ (10)^2 \times 46.8}{(1.05)^5} = 2.24 \text{ lb./in.}^2$$

This value is too low. If we plot Δp against Q on log-log paper the result will be approximately a straight line. If the range extends above and below the critical velocity more than two points must be taken. Fig. 6 shows the plot of the two points just figured. From the curve we see that for a value of 5 lb./in.^{2} per 100-ft. pressure drop, the flow is 15 gal./minute.

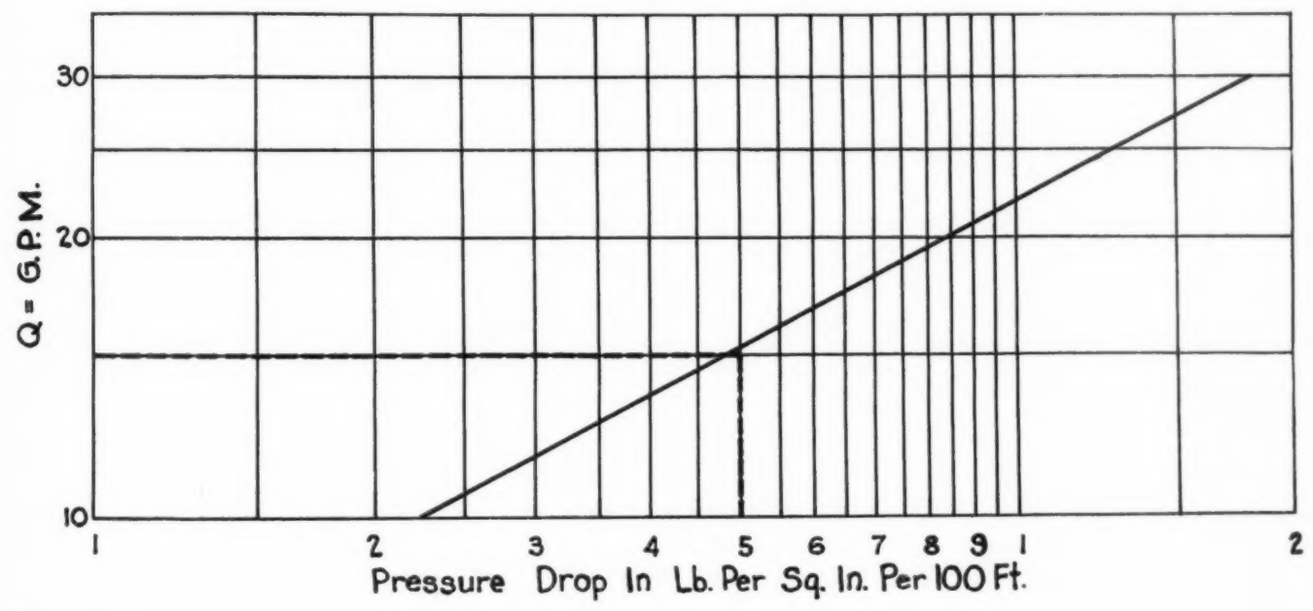
Another type of problem is to find the pipe diameter when the rate of flow and pressure drops are given. This problem must be solved in the same way as the above example, that is, by figuring the pressure drop for two diameters and plotting the results on log-log paper and find the correct size by interpolation.

For streamline or viscous flow: $f = \frac{64}{R}$, and the equation for pressure drop reduces to:

$$\Delta p = \frac{184\ \mu\ l\ V}{d^4}$$

This formula applies if the Reynolds number does not exceed

Fig. 6



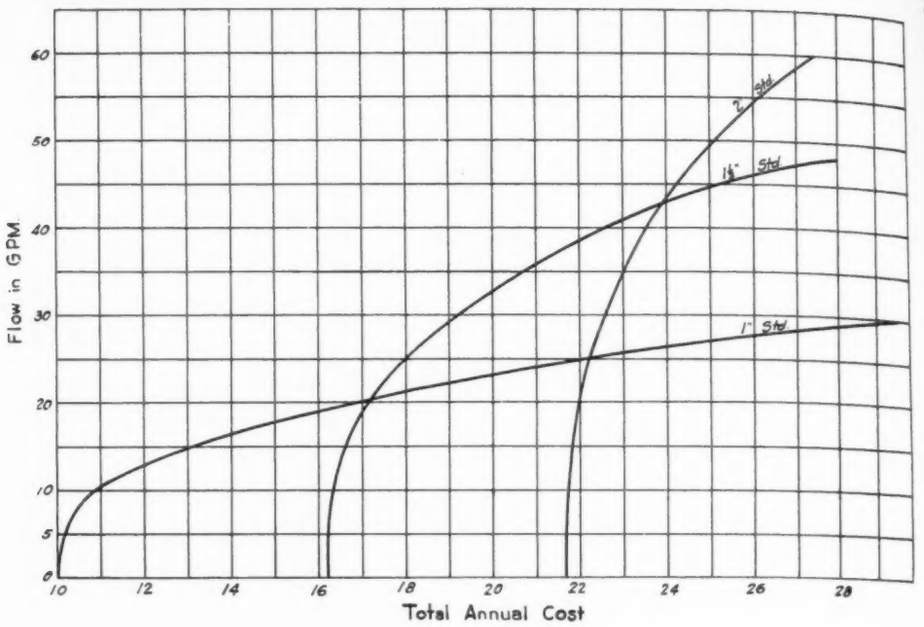


Fig. 7

2000. When the Reynolds number exceeds 2000 the formula for turbulent flow should be used.

3. Consider that it is desired to find the differential pressure necessary to cause 0.01 ft.^{3} of oil at 50 deg. fahr. having a specific gravity of 0.9 and viscosity as shown in Fig. 4 to flow through a 1-in. pipe, 100 ft. long. From Fig. 4 the kinematic viscosity is 1200 centistokes = 12 stokes or μ = .726 lb./ft. × sec.

$$R = 15.3 \times \frac{.01 \times (.9 \times 62.4)}{1.05 \times .726} = 11.3$$

so the flow is shown to be viscous and the pressure drop can be calculated from:

$$\Delta p = 184 \times \frac{.726 \times 100 \times .01}{(1.05)^4} = 110 \text{ lb./in.}^2$$

If this oil is heated to about 245 deg. fahr. the viscosity is reduced to about 1/200 of its value at 50 deg. fahr. and the Reynolds number would be about 2260 and the flow would be turbulent.

There is also the problem of finding the most economical pipe size to use. In many cases, the pipe size is determined from practical considerations, but if data on cost of the pipe installed, its rate of depreciation, etc., are known, the most economical size can be determined. Consider as an example a new steel pipe to carry water eight hours a day for 364 days a year. The fixed charges on the pipe, including interest, depreciation, taxes, etc., are taken as six cents per lb. per year and the power cost, assuming the fluid has to be pumped, has been taken as two cents per hp-hr. when delivered to the fluid in the pipe. This includes losses in the motor and pump. Table 3 shows the tabulated results of pressure drop, power cost, fixed charges and total cost for 1-in., 1½-in., and 2-in. pipes. Fig. 7 shows a plot of the annual cost per 100 ft. of pipe against quantity of flow. This curve shows that the range of application of the 1½-in. pipe size is between 20 gal./min. and 43 gal./minute. Below the lower value the fixed charges of the 1-in. pipe make it cheaper to use and above the higher value the excessive power costs make the 1½-in. pipe too expensive. While these curves are not complete, they show the use to which the principle can be put. These calculations are not particularly difficult to make if the charts given in the following section are used.

The equations given apply to circular pipes. Often it is necessary to make calculations for non-circular shapes, annular sections, and sections with a free surface. In order to work out problems dealing with such sections a term called "mean hydraulic radius" has been devised. The mean hydraulic radius is based on the supposition that the resistance for pipes *having the same area* is proportional to the amount of fluid in contact with the pipe surface. If we represent this mean hydraulic radius by M, we have:

$$M = \frac{\text{Net area of cross-section}}{\text{Wetted perimeter}}$$

The diameter that gives the same pressure drop at the same velocity is 4M or four times the mean hydraulic radius. Experimental data show that there is little error for ordinary shapes in using this mean hydraulic radius for turbulent flow. There is, however, a possibility of introducing a large error when the flow is viscous. A summary of the work on flow through non-circular sections is given by Peters in Hydraulic Transactions, A.S.M.E., August, 1933, p. 29. These data are given in the comments of the writer's paper and show some very interesting results.

Chemical Method for Removing Mud Sheaths in Oil Wells

A chemical method for effectively removing mud sheaths behind perforated oil strings and liners to permit the oil to enter the wells where formation pressures are low, has been devised by engineers of the United States Bureau of Mines, Department of the Interior.

The removal of these mud sheaths that are deposited against the faces of productive oil sands during rotary drilling, or during subsequent conditioning of wells that are shut in temporarily during periods of overproduction, by filling the well opposite the producing formation with mud fluid, is an important problem confronting operators. Certain authorities have estimated that "mudding" or sealing of oil sands has been responsible for the irretrievable loss of millions of barrels of oil in low-pressure sands in California.

Different types of mechanical perforation washers, down swabs, and agitators are used at present for breaking down the mud sheaths and removing the disintegrated clay particles from wells after the perforated pipes have been inserted. Many wells that otherwise would have been non-producers or producers of only small amounts of oil daily have been made to produce oil at a profitable rate by washing the mud sheaths from the faces of the sands with oil or water, but these and other mechanical methods have certain limitations and faults.

The removal of mud sheaths by chemical methods was first suggested to Bureau of Mines engineers by several California operators, and as a result, laboratory experiments were performed to investigate the applicability of these chemical methods.

The method, described by H. C. Miller and G. B. Shea in Report of Investigations 3249, "Chemical Method for Removing Mud Sheaths in Oil Wells," proposes to add a small amount of calcium carbonate (preferably pulverized limestone) to the mud fluids before they are introduced into the wells. The resultant mud sheaths will be susceptible to disintegration by inhibited hydrocholric acid solutions when it is desired to expose the faces of the oil sands in the wells. The method is based on the well-known fact that effervescence is produced by the escape of carbon-dioxide gas in innumerable small bubbles when hydrochloric acid is brought into contact with limestone.

The laboratory work showed that when 20 to 30 lb. of pulverized limestone (paving dust) is added to the barrel of mud fluid of average weight, the resultant mud sheath could be disintegrated by a 15 per cent aqueous solution of hydrochloric acid and the oil sand exposed. Inhibited acid solutions are recommended because the addition of an inhibiting agent almost completely arrests the action of hydrochloric acid on oilwell casings and well equipment without affecting the action of the acid on the limestone in the mud sheath.

Although the investigation was carried on in a small-scale apparatus in the laboratory and no verifying field experiments have yet been made, the writers are of the opinion that results comparable with those found in the laboratory can be obtained in actual wells.

Report of Investigations 3249, can be obtained without charge on application to the Information Division, U. S. Bureau of Mines, Washington, D. C.

Midland Gasoline Co. Moves Offices

The Midland Gasoline Company on September 1 moved its offices from 1303 Esperson Building, Houston, to Conroe, Texas. The new address is Box No. 26.

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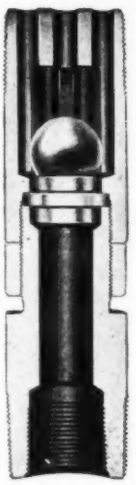

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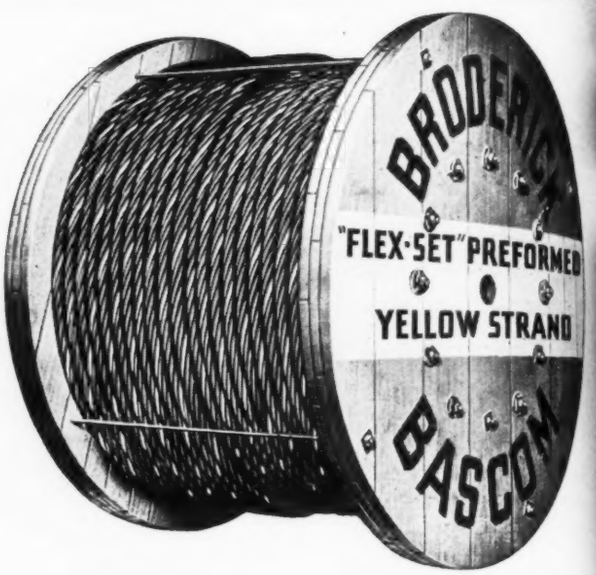

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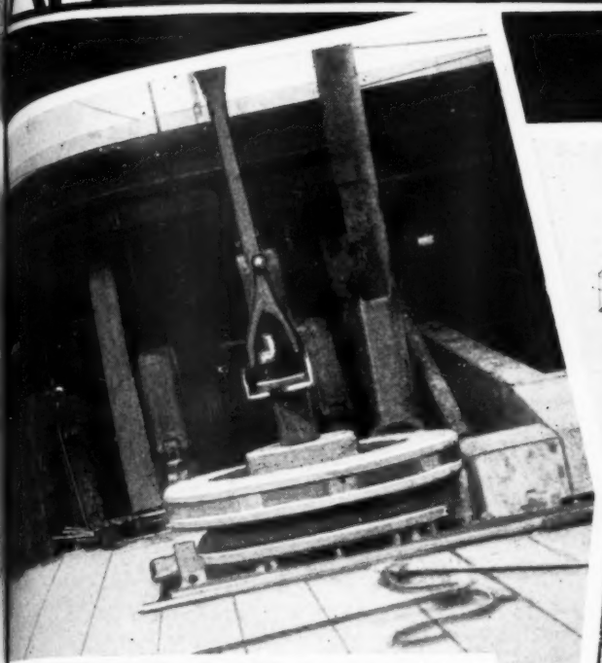
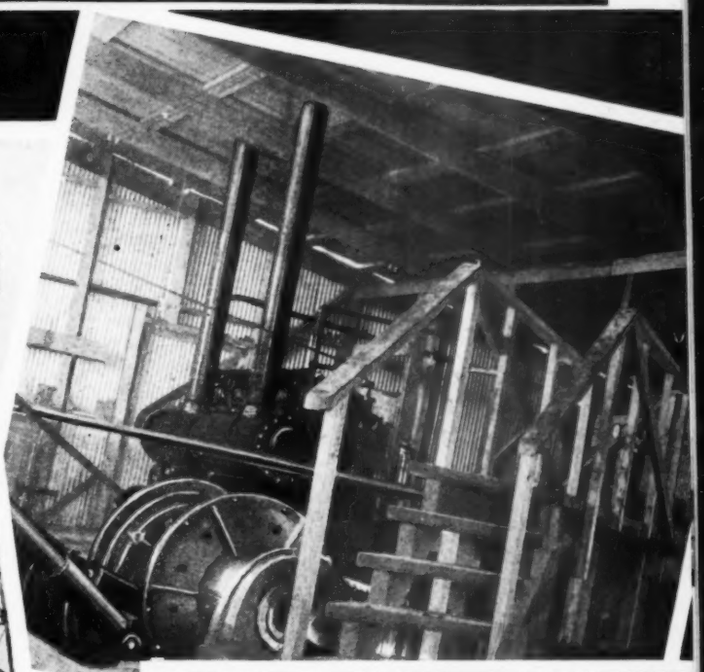
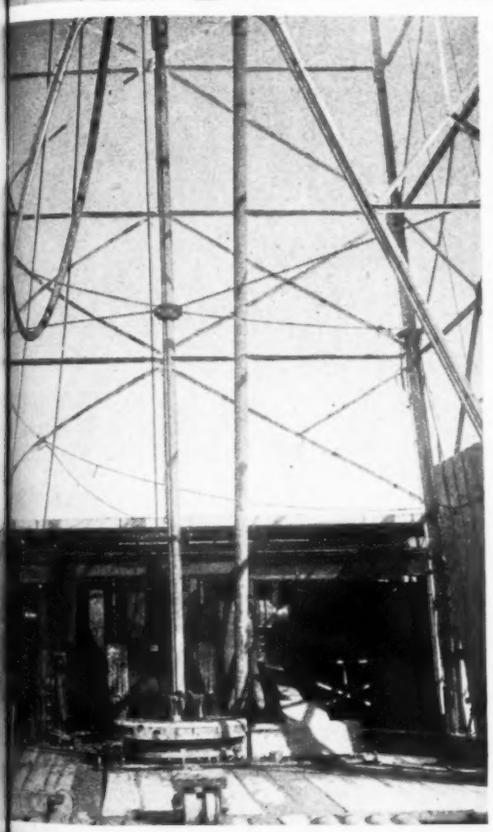
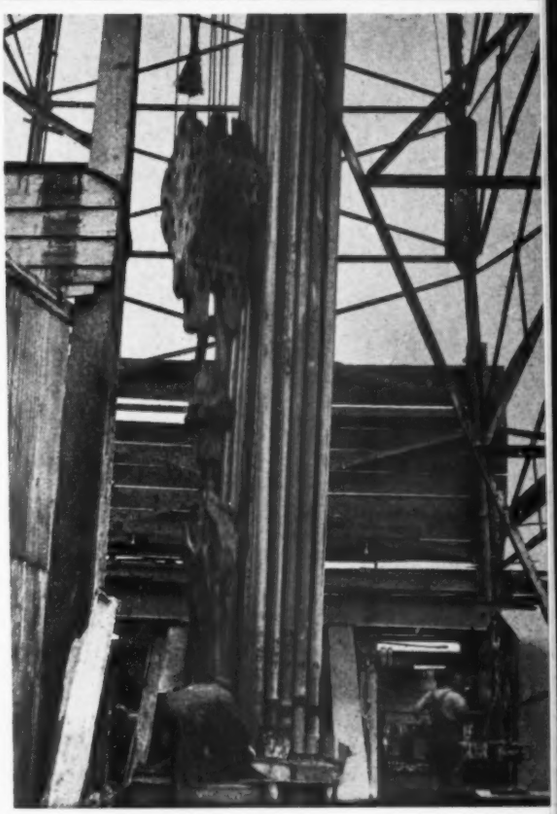
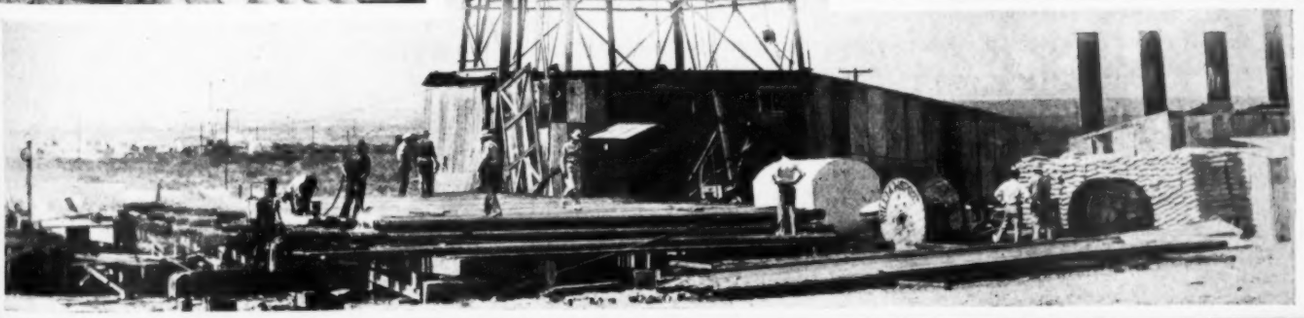
MODERN·DEEP·DRILLING AND·CORING·PRACTICES











Chanslor-Canfield-Midway Oil Company, Hobson A-2, California; depth 10,054 feet

Mid-Kansas Oil and Gas Company and Ramsay Petroleum Company, Preston-Culp No. 6, Cement, Oklahoma; depth 10,079½ feet

Western Gulf Oil Company's Bradley No. 1, Santa Maria, California; depth 10,396 feet

Penn-Mex Fuel Company's No. 35 Jardin, Alamo, Vera Cruz, Mexico; depth 10,585 feet

Modern Deep-Drilling Practice

By K. C. SCLATER

DRILLING difficulties increase with depth. Despite this fact, deep-drilling records continue to be made. The frequent notable depth records made in recent years would seem to emphasize the fact that deep-drilling practice is in an active state of evolution. The trend is significant.

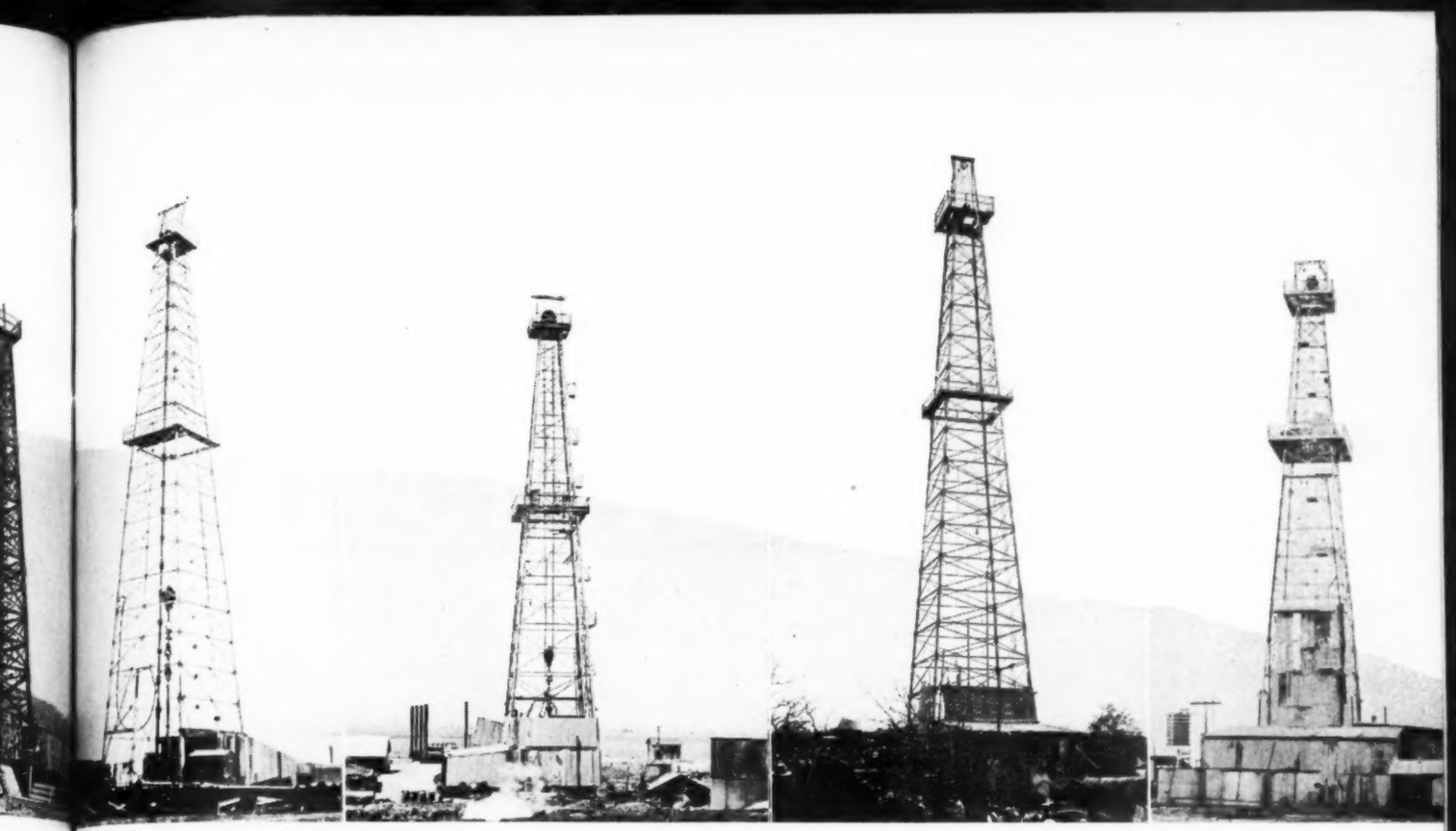
The first well to pass a depth of 10,000 ft. was drilled three years ago in California. It reached a total depth of 10,054 feet. Since then, a depth of 10,000 ft. has been exceeded in seven more wells, the deepest of which, at this writing, is 11,377 feet. This is a total increase in maximum drilling depth of 1323 ft. for the three-year period, or an average of 441 ft. a year for the last three years. The average increase in maximum drilling depth if taken over the last 75 years, or since the Drake well was drilled, is found to be 150 ft. a year. Evidently, the average yearly increase in maximum drilling depth has at present a pronounced upward trend, a fact that is indicative of the status of modern deep-well drilling practice.

These deep-drilling records have not been confined to any one district, for of the eight wells that have reached a depth greater than 10,000 ft. one has been drilled in Mexico, one in West Texas, two in Oklahoma, and four in California. So far as it concerns modern drilling practice, the significance of these deep records is that they are markers of progress in the art of deep drilling. The consistent increases in maximum drilling depth such as witnessed in these eight wells during a three-year period is signal proof of the great progress that has been made in recent years.

Deep development projects are now in progress in many districts, particularly the Gulf Coast, West Texas, the Mid-Continent, and California. In all these districts underground conditions are such that the rotary system is employed almost exclusively for drilling deep wells.

Modern drilling practices are generally recognized, although they may vary in detail among the districts because of the local drilling difficulties encountered. Straight-hole drilling, close control of bit pressure, constant control of the drilling mud to meet the changing conditions in the hole, frequent coring, taking the necessary precautions to guard against blow-outs, floating-in casing, and care in placing the cement are some of the important phases of modern drilling practice now widely used.

Attention to these items by operators has brought about a finer discrimination in the choice of methods and equipment. This discrimination has been acquired by impartial and competent observation and tests. Reliable records are kept of the



Gulf Production Company's No. 103 McElroy, Upton County, Texas; depth 10,631 feet, July 16, 1934

North Kettleman Oil and Gas Company's Lillis-Welsh No. 1, Kettleman Hills, California; depth 10,994 feet, before plugged back by cavings

Denver Producing and Refining Company's Adak-Noc No. 1, near Binger, Oklahoma; drilling below 11,000 feet, June 23, 1934

General Petroleum Company's Berry No. 1, Belridge field, California; depth 11,377 feet, May 29, 1934

service and performance rendered by equipment. Improvements or defects soon become evident under actual field operating conditions. Procedure such as this has resulted in greater coöperation between the users and manufacturers of drilling equipment. The problems of the user and the maker of equipment are mutual, and recognition of this fact has played a large part in the rapid development of efficient deep-well drilling methods.

Texas and Gulf Coast Deep-Drilling and Coring Practices

Unconsolidated sands and shales predominate in the fields of the Gulf Coast. Another geologic feature peculiar to the district is the existence of salt domes. These subsurface features have had an important influence on drilling practice and account for exclusive use of the rotary system.

Derricks in general use for drilling deep wells are the 122-ft. A.P.I. standard steel derrick. In areas of high gas pressure, or at deep wildcat wells, steel substructures are employed in preference to underground cellars in order that free access can be had to blow-out and master control connections below the derrick floor. In such cases the drilling machinery usually is set on a steel substructure level with the derrick floor.

Blow-outs have been frequent in the fields of the Gulf Coast and it is considered good practice to install a blow-out preventer as soon as the surface casing is landed in areas where there is any possibility of a gas blow-out.

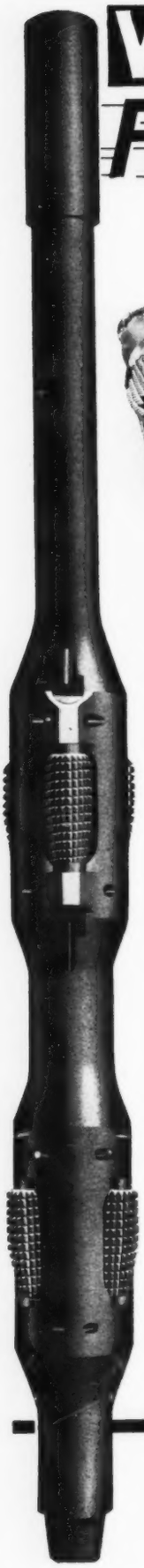
Surface formations are soft and easy to drill, but the presence of heaving shale in certain fields requires the exercise of the greatest care. The application of mud control in overcoming heaving shale is discussed elsewhere in this section.

Mechanical means of controlling heaving shale are also in use. In the McFaddin field, where several serious blow-outs have occurred, with subsequent cratering, pressure drilling with 5-in. 20.50-lb. internal upset drill pipe equipped with external flush joints has been adopted to aid in overcoming the trouble. Pressure in the well while drilling is controlled by chokes on the circulation return lines, of which there are two 7-in., each fully equipped with two plug valves for quick opening or closing.

The cavey nature of the formations in the average deep well in the Gulf Coast is much greater than normally encountered elsewhere, and constant control of the mud while drilling is practiced by all operators. The density of the mud is automatically measured by a recording mud scale or hydrometer, or by frequent density readings at regular intervals. Mud weights of 9½ lb. to 10½ lb. per gal. are used under average drilling conditions.

Both drag-type bits and rock bits are in general use. Means for keeping holes straight consist of controlling the bit pressure with the use of guides such as reamers, long heavy collars, or lace joints on the bottom of the drill stem above the bit.

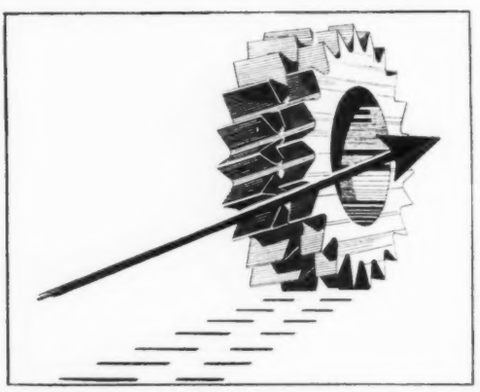
WHY REED BITS MAKE FASTER SAFE STRAIGHT HOLE with LESS WEIGHT



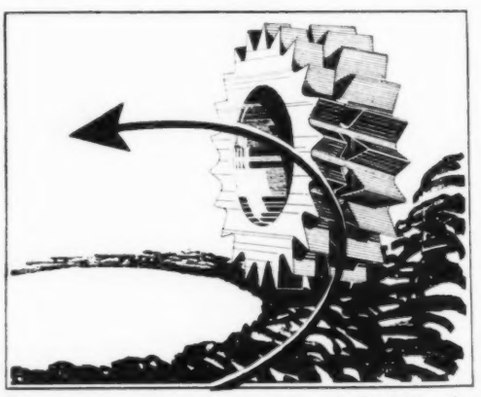
TEARING ACTION OF THE NEW REED ROLLER BEARING ROCK BITS

makes bits **DIG** with light weight as the cutter teeth penetrate

TEARING ACTION DEMONSTRATED



When rolled in a straight line, cutter does not tear the surface



When forced to take a circular path, as in Reed Bits, the *constant changing of direction* from a straight line causes the cutter teeth to *TWIST* and *TEAR* the formation as they *PENETRATE*.

REED REAMERS

for STRAIGHT HOLE DRILLING
CONCENTRATING WEIGHT PERPENDICULARLY ON THE DRILLING BIT
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FULL GAGE, SMOOTH WALL HOLES

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Drilling Coring Bits

SAVE TIME and MONEY BY EITHER DRILLING or CORING

Without pulling drill stem

This saving of expensive round trips means:

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2. Reduced Drilling Line Costs
3. Lessened Rig Wear and Repair

DRILLING: Overshot withdraws collapsible blade bit. New, sharp, heat-treated blades substituted for dull ones.

CORING: After a full length core is cut in the usual manner of rotating and circulating, the core barrel is removed by an overshot.

CERTAIN and ECONOMICAL for DRILLING THROUGH and SETTING CASING in

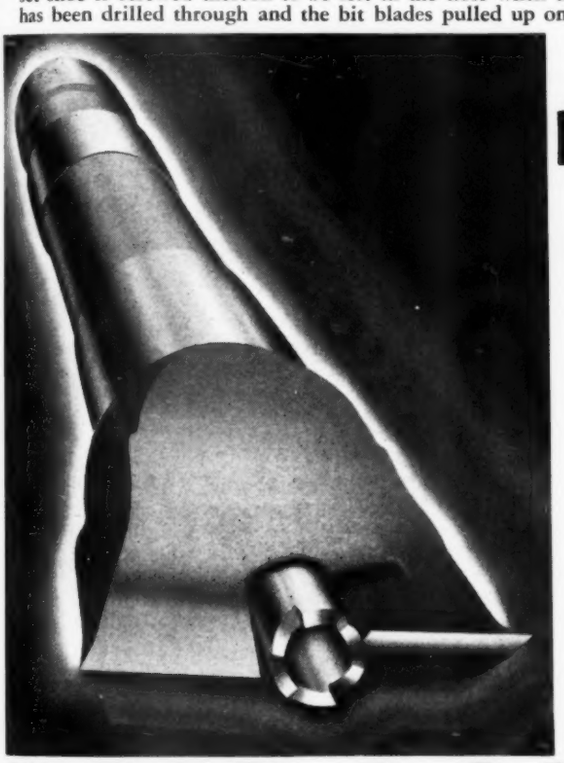
HEAVING SHALE

It is not necessary to pull the drill stem and disturb heaving shale, causing it to heave. Casing is used as drill pipe and a combination bit head and set shoe is screwed thereon to be left in the hole when the heaving shale has been drilled through and the bit blades pulled up on the overshot.

Drilling blades expanded and locked for drilling

Drilling blades collapsed and being withdrawn with overshot

Large bore bit head set as casing shoe in heaving shale jobs



REED BARRETT-ROBISHAW WIRE LINE DRILLING CORING BITS

PERMIT THE TAKING OF CORES WITHOUT THE REMOVAL OF THE DRILL STEM FROM THE HOLE

EASE OF TAKING CORES MAKES MORE WELLS: Obviates the tendency under old methods where the drill stem must be pulled to get a core, to minimize the number of cores taken and thereby miss important formation changes.

The Core Barrel is recovered up through the drill stem with the wire line. Keeps walls of hole in better condition where frequent coring is necessary. May be operated through A.P.I., Acme, or Full Hole Tool Joints.

Take 10-foot cores with an average of 85 per cent recovery where used on drill pipe equipped with Full Hole Tool Joints.

Especially adapted to use in any formation where fish tail or drag bit drilling predominates.

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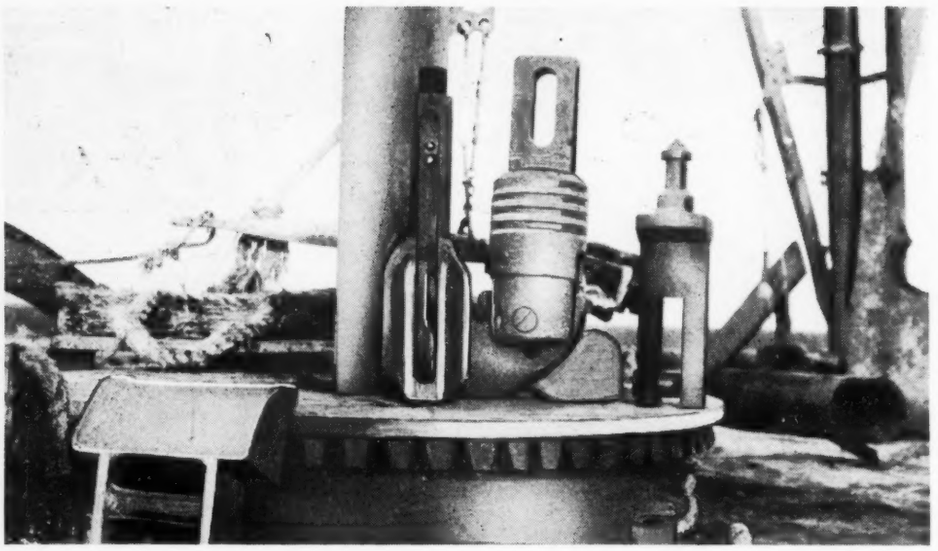


Wire line collapsible bit with carrier and overshot for 13⅜-in. hole, used in a well in Southwest Texas

Coring by means of the wire line drilling-coring bit is used on the Gulf Coast in areas where the formations are not too hard to drill. In the wire line coring tool the bit is of the regular fishtail type or of similar design, except that it has a center hole to accommodate the core barrel and core bit. In use, the drilling bit, drill collar, and sub are attached to the drill stem and run in the hole to operate in a manner similar to the ordinary fishtail bit. When a core is to be taken, the kelly joint is unscrewed and the core barrel assembly is dropped inside the drill pipe to its operating position, which it assumes automatically. The kelly joint is replaced and the drilling resumed until the desired length of core is out.

How the mud is controlled during coring will depend on the formation being cored. Usually the pump is run slowly, and in very soft or loose formations the pump may have to be shut down to pick up the core.

To recover the core, the kelly joint is unscrewed and an overshot run in the drill stem on a wire line from an auxiliary reel. As the overshot reaches the core barrel, it engages and attaches itself to the spearhead of the carrier body. The first upward pull on the line releases the core barrel, which is then recovered from the drill stem. If desired, the drill stem may be rotated while the core barrel is being recovered.

Pulling of the drill pipe is obviated when a core is taken with this unorthodox type of drilling-coring bit. A core has been taken in a Gulf Coast well with this tool from a depth of 8264-8266 ft. in an elapsed time of about 85 minutes. On the chart (see illustration) a graph is plotted showing the time taken to obtain cores at various depths.

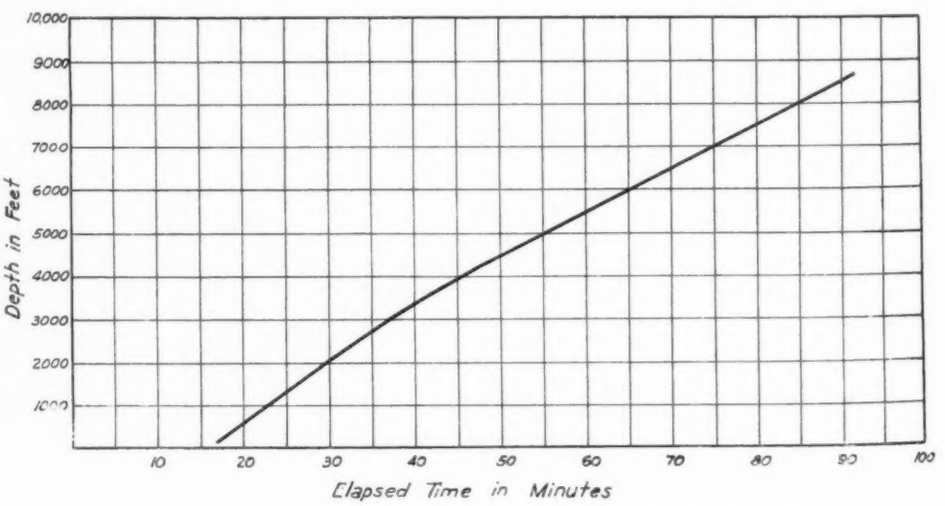
From two to three strings of casing are used on the average deep wells. It is standard practice also to set a screen or liner in the pay sand. In floating-in casing in deep wells it is customary to use a cement guide shoe on bottom, and at least one cement float collar a few joints above the shoe.

Before setting casing or screen pipe the mud is treated, put in uniformly good condition, and circulated in the well for a time to insure that the circulation is free.

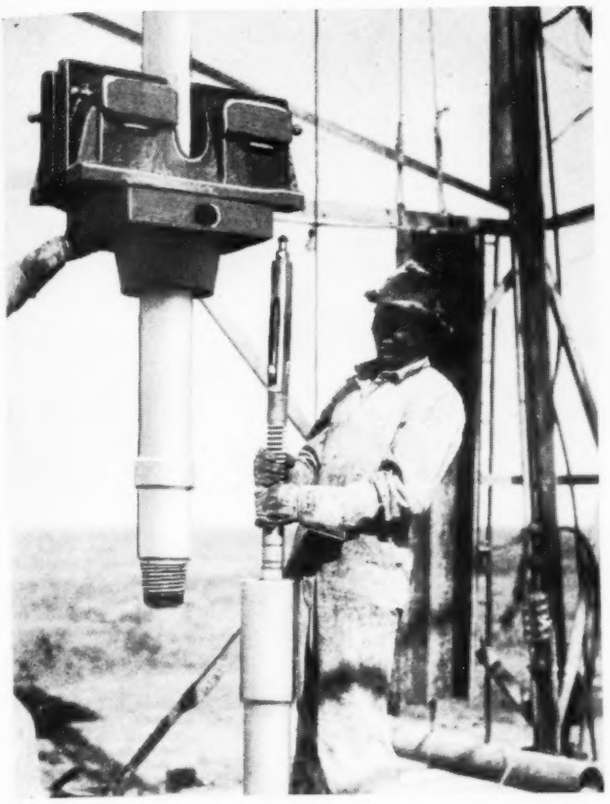
Screen may be set by running either on the drill pipe or the tubing. When run on the drill pipe the screen is set in place and washed on the outside with clear water. The screen is then sealed to the casing, after which the drill pipe is released from the screen and seal by means of a special tool for this purpose. Mud is then circulated to displace the water, after which the drill pipe is pulled and the flow tubing run in the hole. After the Christmas tree is connected the screen is washed inside and the mud carefully displaced sufficiently to allow the well to flow. Setting the screen by this method allows running the tubing inside the screen to bottom if desired.

When the screen is run on the tubing, it is run in and set on bottom. The Christmas tree is then connected and the screen washed outside. The screen is then sealed to the wall of the casing by rotating the tubing, which expands the sealing device. This frees the liner from the tubing, which is then lowered onto a lead seat, thus making a seal between the liner and tubing. Setting the screen in this manner permits the screen to be set and washed in one operation and with the Christmas tree in place.

Several of the companies have adopted standards for equipping, rigging up, and dismantling drilling wells. By so doing, much duplication of effort is avoided, operations are speeded up, and drilling costs are reduced. Equipment is moved from one location to another in orderly fashion. Each piece of the drilling rig is unloaded at the location and placed on the ground according to standard plans. Details have been worked out that make for safety and efficiency. Such new practices show the efforts being made to increase the efficiency of modern drilling methods.



Graph showing average time required to obtain cores at various depths with wire line coring bit



Inserting core bit in drill stem preparatory to taking a core on a well about 4000 ft. deep in the Manvel field, Texas Gulf Coast

Modern Maritime Drilling Practice

Conspicuous examples of maritime development operations are those found on the Gulf Coast of Louisiana and Texas, on the Maracaibo Lake, Venezuela, and on the tidelands of California.

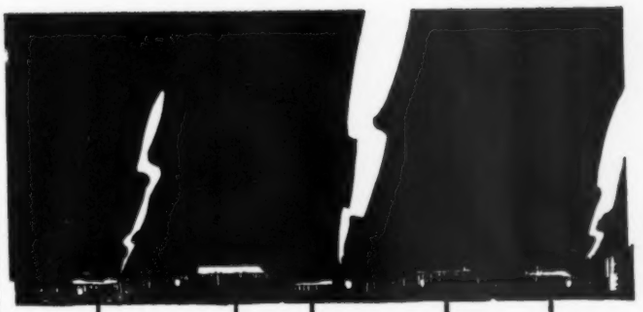
Of these operations the most widespread and active are those of the Gulf Coast. The old fields first developed in this district are in shallow bays or water inlets. More recently development operations have been extended to deeper water and the drilling depths are much greater.

Methods of transporting and placing of the drilling machinery are being revolutionized. Rigging up and dismantling is slow and costly under the ordinary methods of setting all drilling machinery and rig equipment on piling.

Operators are now placing drilling equipment on floating steel barges. Floating drilling equipment was introduced about three years ago when it was successfully used to drill a group of shallow sulphur wells on the Jefferson Island Dome, where the water is from 10 to 15 ft. deep. A special steel barge was built to carry all the drilling rig and machinery.

The success of this barge led to the adoption of floating equipment by oil companies engaged in large-scale maritime development operations.

One of the major companies has had in operation for some



Wells Drilled Deeper Than Ever Before —
Through Hundreds — Even Thousands — of Feet of
HEAVING SHALE
by the Use of
AQUAGEL BAROID & STABILITE

A LARGE enough number of wells have now been successfully completed through "heaving shale" in the Gulf Coast Fields to definitely prove the possibility of drilling through these shales if the proper procedure is followed.

Practically all of these successfully completed holes have used AQUAGEL, BAROID and STABILITE and have observed the following precautions:

1. Make hole slowly in the shale — about 40 to 50 feet per day.
2. Add AQUAGEL to provide the "gel-forming colloids" to wall-up the hole.
3. Add BAROID to keep the weight of the mud at 11 to 12 lbs. per gallon, to provide pressure against the walls of the hole and to insure speedy wall building.
4. Add STABILITE to keep the viscosity of the mud between 45 and 50 seconds on the Funnel Viscosimeter.

Detailed information gladly furnished without charge or obligation. Stocks carried and service men available in all active oil fields.

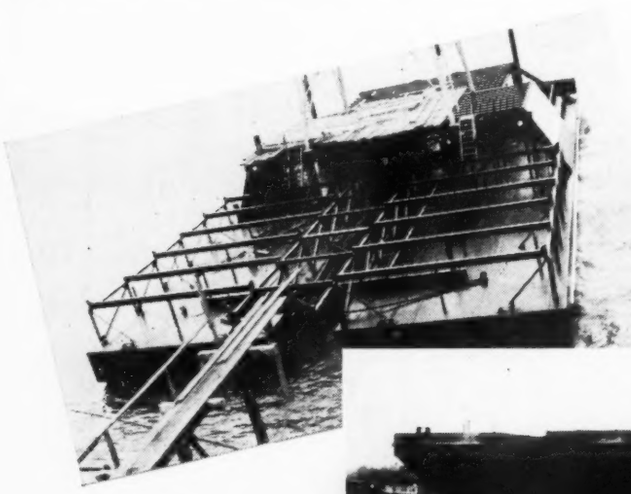
A Complete Drilling-Mud Service

BAROID SALES CO.
LOS ANGELES • HOUSTON
National Pigments & Chemical Co.
ST. LOUIS

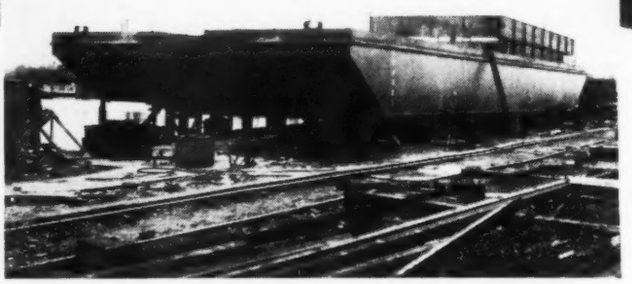
time a twin-hull steel barge on which is mounted a complete steel drilling derrick, drilling machinery, drill pipe and casing. The barge can be sunk in water up to ten ft. in depth and, with the drilling equipment, is designed for drilling to a depth of 10,000 feet.

The barges of the twin-hull are each 24 ft. by 110 ft. by 10 ft. deep and are rigidly connected by a steel super-structure with an 8-ft. trough, or bay, between. They are of copper-bearing steel to meet the water conditions and are well without disturbing the well connections, which may protrude 30 ft. above the water level.

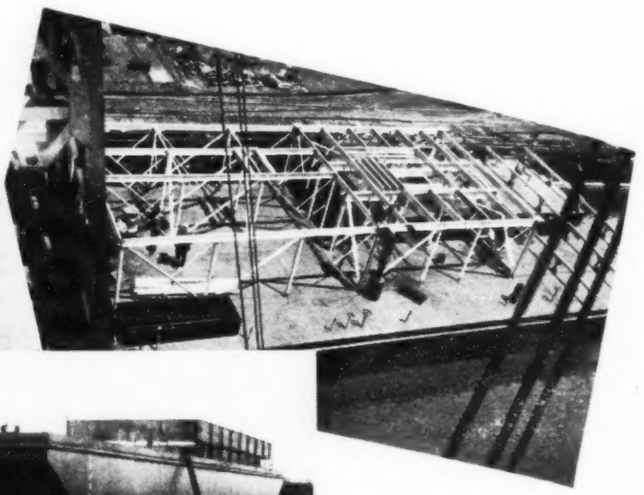
One of the many interesting features of these barges is that they are constructed with compartments into which water is introduced for sinking the barge on location to the bed of the lake or ocean floor. After the well is drilled the water is pumped out of the compartments, the barge refloated and moved to another location with its full complement of equipment.



Above — View of barge showing bay extending beyond mud cellar



Right — View of 90-ft. by 40-ft. by 8-ft. single-hull steel drilling barge, showing the mud ditch



Above — Single-hull steel drilling barge with steel superstructure ten ft. high

of all-welded fabrication. The construction and design of each barge are standard hull transportation.

The derrick and engine are mounted on a superstructure of all-welded structural steel with derrick floor space of 24 ft. by 44 ft., at a height of ten ft. above the main decks of both barges, and an engine house 26 ft. by 30 ft., also ten ft. above the main decks.

Five ft. above the main deck a drill pipe rack and a casing rack are provided, each of which is 24 ft. by 45 ft. in size. Removable brackets in the truss work of the superstructure allows floating the barges away from a completed

Before the barge was used it took from three to 18 days to rig up; with the barge only from six hours to two days are required to make a move from one location to another and be ready to spud in the well.

Large barges of single-hull design are also in operation. One recently put into use has a power plant consisting of two units, each consisting of a 242-hp. Cooper-Bessemer Diesel engine direct-connected to a 480-v., 514-r.p.m., 264-amp., 219-kva. Westinghouse generator. This floating power plant generates power sufficient to drive a modern heavy electric-driven rotary and mud pumps.

Heaving Shale and Mud Control

In the fields of the Gulf Coast the true heaving shale is encountered principally in the Vicksburg and Jackson shales in localities where these formations have been uplifted and stand at a substantial angle to the horizontal. Compared with other shales, both these shales contain a relatively large quantity of colloidal matter, and will disintegrate to mud upon mixing with three to four times their weight of water. Disseminated throughout the shale bed are layers or shells of hard, brittle shale that is almost entirely devoid of colloidal matter and consequently has no mud-forming properties. Oil and gas sands varying in thickness from a fraction of an inch to several feet are also found throughout the shale beds.

When these shales are drilled with the ordinary native mud, that is, mud made from the shales lying immediately above the Vicksburg or Jackson, no difficulty is encountered for the first 24 to 72 hours. After drilling this length of time, the walls of the hole begin to cave and heave. Each successive heave appears more violent, that is, the amount of hole lost becomes greater, and more effort is required to withdraw the drill pipe through the heaved shale. In many instances the heaves are preceded by blow-outs.

It is generally agreed that the heaves are directly resultant from water being squeezed from the drilling mud and entering the shale bodies. The free water converts part of the shale to mud and leaves layers of harder shale unsupported and ready to cave into the hole. Another contributory factor is the type of mud that is produced from the incursion of water to the shale. It is low in weight, and high in viscosity and gel strength. All these qualities are conducive to gas-cutting of the mud, which, if allowed to continue, will

result in a blow-out. The high gel strength also causes an aggravated swabbing action of the bit while coming off bottom, sometimes great enough to pull into the hole the unsupported and loosely-held shale.

The successful combating of this problem, therefore, must include the accomplishment of three things, namely: (1) holding to a minimum the transfer of water from the mud to the shale; (2) maintaining mud of sufficient weight to offset the gas pressure in the sand lenses and the reduction in bottom-hole pressure due to withdrawal of the bit; (3) maintaining in the hole a mud of low viscosity and low gel strength.

Mud that will fulfill these three requirements can be made by the proper admixing of Aquagel, Baroid and Stabilite. No. 3 Aquagel, being almost wholly gel-type colloidal clay, combines with the free water in the mud and holds to a minimum the amount of water that can be separated from it. The weight of the mud is controlled by the proper addition of Baroid. The mud viscosity and gel strength are reduced to the proper degree by frequent treatment with Stabilite No. 3, a liquid chemical that reduces both the viscosity and gel strength of the mud without altering its colloidal content.

The greatest success in the prevention of heaving shale has been attained by adjusting the mud to a weight of 11 lb. per gal. and a viscosity of 35 to 50 seconds on the Marsh funnel viscosimeter *before* entering the shale. The sequence of operations is first to remove all gas and sand from the mud, and to reduce its viscosity and gel strength by treating the native mud with Stabilite No. 3. After the mud has made several complete cycles of circulation and is free of sand and gas, Baroid No. 3 (containing 3 per cent Bentonite) is added in sufficient quantities to result in a mud weight of 11 lb. per gallon. If insufficient Stabilite No. 3 has been added to the mud in the first step, the 11-lb. mud will have a viscosity greater than 50 seconds. In this event additional treatments of Stabilite No. 3 must be made until the viscosity is reduced to the proper limits, 35-50 seconds.

As drilling proceeds in the shale, the mud weight will slowly be reduced and the viscosity will rise. Periodically, the weight and viscosity must be restored to the original specifications by the addition of the proper quantities of Baroid No. 3 and Stabilite No. 3.

It is not presumed that a mud of 11 lb. per gal. and 35 to 50 seconds viscosity will control all wells that give trouble from heaving shale; it is an initial specification employed on the majority of wells wherein a mud control program has been instituted, and represents the first point of a flexible control.

In one particular case of shale control, the mud weight had to be increased to 13 lb. per gal at 50 seconds viscosity before the tendency to heave and blow out was stopped.

Drilling mud control alone is not sufficient to prevent heaving shale, it must be supplemented with careful and slow drilling. In aggravated cases drilling speeds have had to be reduced to 75 ft. per day. If the heaving formation is drilled too rapidly, it does not allow sufficient time to elapse for walling up and sealing one gas lense or troublesome area before several others are exposed in the open hole.

In putting a mud control program into effect it is of particular aid to keep an hourly record of the mud weight and viscosity, together with notations of the quantities and kinds of drilling mud admixtures used. Such a log will show not only the immediate condition of the mud but also the condition during the past 24 to 48 hours, thus giving the operator a check on the uniformity of his mud control. A convincing field test on mud control has recently been completed in the Pierce Junction field. In 1930 one of the operators in that field drilled 400 ft. into the Vicksburg formation. The mud weighed between 11 and 13 lb. per gallon, but no viscosity record was available, for at that time the practice of making field measurements of mud viscosity had not yet come into use. During the drilling of this well, the hole heaved 11 times, each time up to or above the casing shoe. Finally a 4¾-in. blank liner was set to within ten ft. of bottom, and the well was produced through the eyes of a 4¼-in. bit and 2½-in drill pipe. A total of 58 days was spent drilling this 400 feet. In the summer of 1934 this operator went back into this same well and whipstocked a 6⅛-in hole out into the shale approximately 600 ft. above bottom. A program of mud control was adopted from the outset, wherein an hourly log was kept of both mud weight and viscosity. The initial control was 11 lb. per gal. at 35 to 50 seconds. After drilling about 300 ft., it was deemed advisable to increase the weight to 12 lb. per gal. and hold the viscosity the same. The drilling mud was built up from an original shale mud of 9.8 lb. per gal. at 120 seconds viscosity by the proper admixing of Stabilite No. 3, Baroid No. 3 and Aquagel. The operator restricted the drilling speed to three ft. an hour.

A total of 11 days elapsed between whipstocking out of the casing and striking the sand 400 ft. in the shale. At no time during the drilling of the second hole did the shale heave or give any trouble. Surveys of the original hole and of the whipstocked hole showed them to be within 25 ft. of each other, consequently, it is fair to assume that the bodies of shale drilled in both holes were identical and that the success of the second hole, compared with the first, was one of mud control alone.

When the second hole proved unproductive, a third hole was whipstocked into the shale with a 6⅛-in. bit. This hole was carried 1250 ft. into the shale, using the same mud control as that employed on the other two holes. No disturbances occurred except two heaves at 1200 ft. in the shale.

Straight-Hole Drilling and Well Surveying

About ten years ago, when positive measurements of vertical deviation began to be taken in wells, the industry gradually awakened to the fact that crooked holes were of common occurrence.

When the detrimental results of crooked holes were investigated they were found to be far-reaching, affecting every phase of development and producing operations.

Although many contributory causes of crooked holes have been brought to light, it is now generally accepted that the chief cause contributing to the deviation of holes is too much pressure on the bit.

In modern deep-well drilling practice, the required limits of deviation are quite restricted, being from 2 to 5 degrees. Holes are surveyed at regular intervals, usually every 250 or 500 ft., while drilling is in progress. The first readings are usually not taken until several hundred feet of hole has been drilled. Well surveying for deviation has now become part of the routine operations of drilling.

Means for keeping the hole straight are taken when the well is spudded in. Care is taken to see that the kelly is properly centered and maintained vertical. To aid in holding the drill stem vertical while spudding in, usually a guide, which is centered by chains or guy wires attached to the four

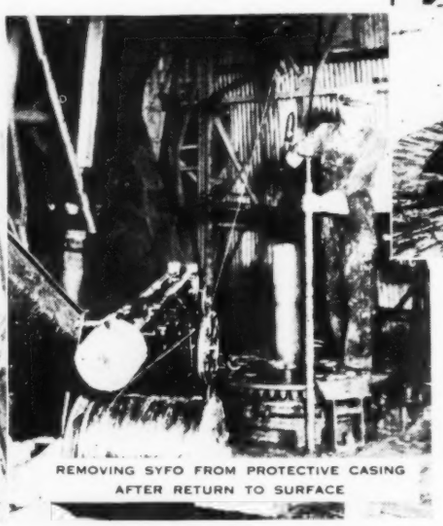
corners of the derrick, is attached to the top of the drill stem. The upper end of the drill stem revolves in the guide and is thus held in a central vertical position.

Bit pressure is closely controlled by means of a weight indicator, and has become standard modern practice. The weight on the bit depends on the formation being drilled and the type of bit being used. The large dial of this instrument is within sight of the driller during the entire drilling of the well. He has come to depend upon it to diagnose almost every type of well condition while drilling.

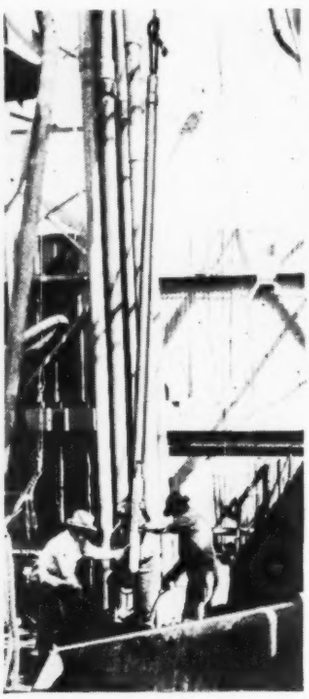
One drilling control instrument is now on the market that indicates continuously the weight on the bit, the torque on the drill-pipe, the slush-pump pressure, the rotary table speed, and the weight of the drill pipe. A recording gauge equipped with three pens gives on a single chart a continuous record of the slush-pump pressure, the torque and the drill-pipe weight.

In general, a reasonably high rotating speed and light bit pressure are usually best for drilling a straight hole. A suitable pump pressure for straight-hole drilling is one that keeps the hole free of cuttings, prevents balling-up of

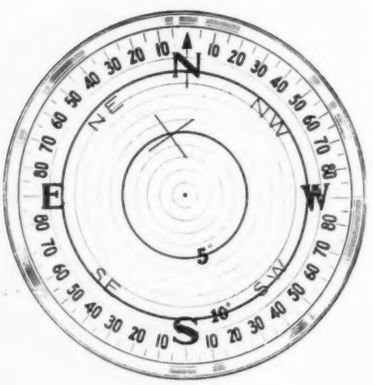
ORIENTING THE GYROSCOPE



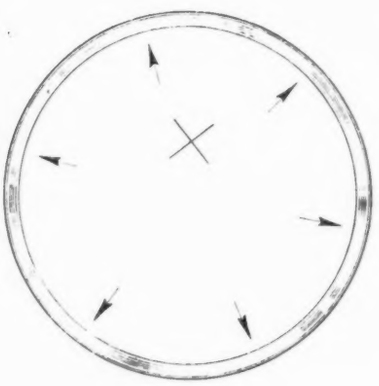
REMOVING SYFO FROM PROTECTIVE CASING AFTER RETURN TO SURFACE



LOWERING BATTERY FILLED LOWER JOINT OF PROTECTIVE CASING INTO WELL



Here is a completed 10 deg. record disk that shows an inclination of 40 deg. 50 ft. in a direction of N. 14 deg. E. The 25 deg. disk has the same compass arrangement, but with inclination circles extending to 25 degrees

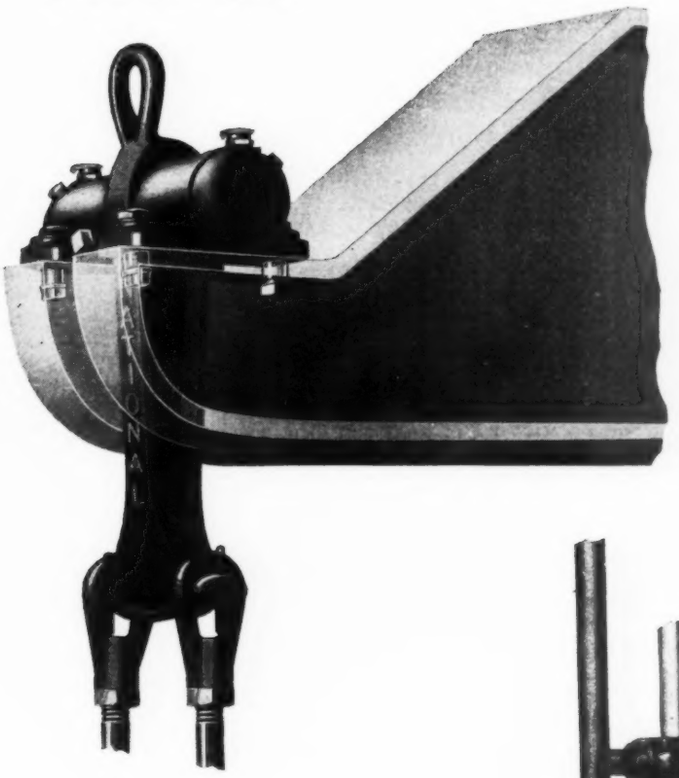


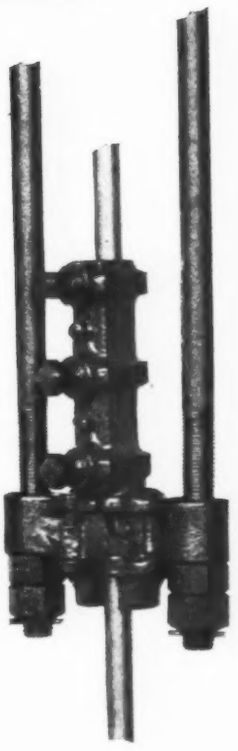
The completed code disk here shown can only be read with readers that have code marks corresponding to the ones on the code compass card

Derrick operator aligning sight device on predetermined distant object and clamping sight socket to the drill pipe during a survey of a well by the Anderson method

GEORGE G. BROWN
2028 E. ENGINEERING BLDG.
ANN ARBOR, MICH.

NATIONAL
BEAM HANGER
TYPE UA





The Type UA Beam Hanger provides a safe, flexible connection between polish rod and any standard underslung type walking beam.

Carefully selected material and high quality workmanship are combined to produce a strong, rugged unit having no hinged joints and but few moving parts.

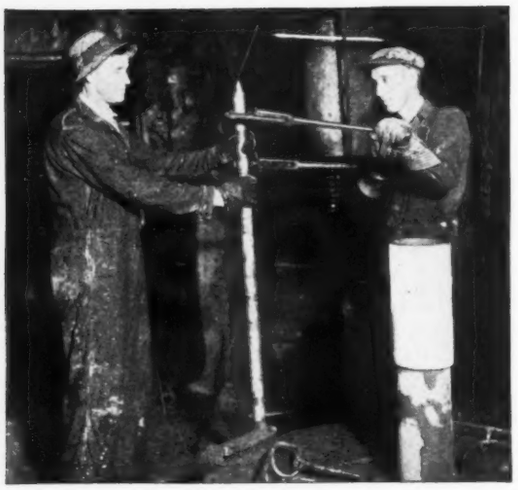
Self-aligning body is mounted on a forged steel bearing shaft, carried in large, bronze-bushed bearings which are completely enclosed and submerged in oil.

The Hanger is furnished complete with reins, 3-bolt positive polish rod clamp and a convenient side-door type clamp support which facilitates quick assembly over the polish rod.

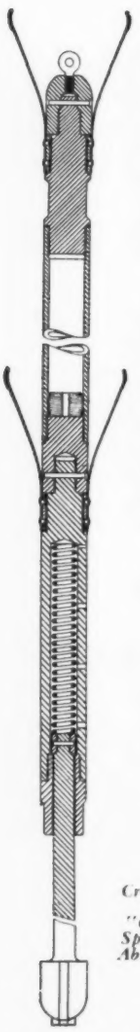
Simple construction, dependable material and positive lubrication insure long, continuous, trouble-free service.

Bulletin No. 44 free on request

THE NATIONAL SUPPLY COMPANY



You can't put a crooked **HOLE** *in jail*



A crooked hole *picks your pockets* . . . cuts down your profits, pushes up your costs. And *you* have to take the punishment. That's why it pays to keep holes straight with SYFO. That's why *you* pay when you "play along with luck."

The SYFO Clinograph is a remarkable device. The records afforded by SYFO Clinograph are direct and accurate records—records that are easily obtained *without the use of dangerous acids*—permanent records on paper that can be filed away for reference.

Write for descriptive literature and rates. Also operators of the Surwel Clinograph.

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Los Angeles, California:
415 Petroleum Securities Building
Houston, Texas: 819 Esperson Building

Cross Section View of "Go-Devil" Spring Shock Absorber Type

Sectional View of a SYFO *Clinograph*

SYFO CLINOGRAPH

(U. S. Patent 1,962,634, and others pending)

the bit, and does not wash against the wall of the hole. If the pressure on the bit is too great, flexure of the drill pipe occurs and a crooked hole results.

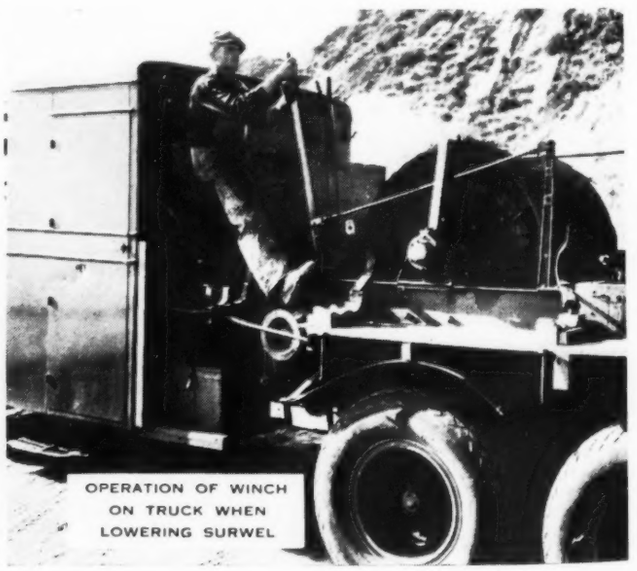
There are numerous methods of surveying wells in use. Among the most widely employed in modern standard practice are the simple acid-bottle methods, the Anderson method, the Sperry-Sun method, and various forms of clinographs.

Most of the acid-bottle methods in use measure only the deviation, but of the others, two give the direction of the deviation as well as its amount.

The Sperry-Sun instrument for determining both the amount and direction of deviation uses the gyroscopic principle for determining the direction of deviation. It works automatically and records deviation and direction of deviation, time, and also the temperature, photographically.

Holes are surveyed by lowering the instrument on a wire line, which is run in at an average speed of 220 ft. a minute. The instrument is lowered 100 ft., stopped and held about 20 seconds and lowered again. It has been used to survey a number of very deep wells, the deepest of which was almost 10,000 feet.

The Anderson method obtains a photographic film record of the readings made by an instrument lowered into the well. This mechanism remains in exact orientation with the drill pipe or tubing on which the instrument is run. During a survey all variations in the orientation of the drill pipe due to turning when running in are measured from the surface. The orienting apparatus is attached to successive stands of the drill pipe and readings taken. The rotation of the drill pipe is measured in order to determine the direction of the reference point of the instrument at the time each photograph is taken in the well. Thus, at each stand length, the photographs give the amount of inclination and the direction of inclination as measured from the reference point of the apparatus, and the orienting calculations give the direction of the reference point at each corresponding position in the hole. This instrument was the first to be used in oil wells for measuring both the amount and direction of deviation.



OPERATION OF WINCH ON TRUCK WHEN LOWERING SURWEL

Mid-Continent Deep-Drilling and Coring Practices

Deep drilling in the Mid-Continent is confined almost entirely to the rotary system. The formations on the whole are harder than those of the Gulf Coast fields. In many cases, notably Kansas, a large amount of drilling is done with rock bits. Holes stand up and serious caving troubles are relatively few.

Up until the discovery of the Oklahoma City field, it was the prevailing practice to drill to the top of the pay sand with the rotary and complete the well with standard cable tools. Great strides have been made since then in deep-well drilling and completions. Deep wells are now drilled-in and completed with the rotary.

Development of the Oklahoma City field marked the introduction of a new era in deep drilling practice in the Mid-Continent. Witness how drilling operations were speeded up. The discovery well, brought in December, 1928, was drilled in 150 days; in 1929 the average drilling time to complete a well to 6400-6500 ft. was 119 days; and by 1932, the average drilling time was 50½ days.

This period was marked by many improvements in drilling practice that were the forerunner of the modern methods in use today. Among those practices that contributed to progress were: the control of mud weight and velocity; straight-hole drilling, including the close control of pressure on the bit; the adoption of rotational speeds and bits to suit the drilling conditions; the use of equipment of modern design; and uniform casing practice.

Thick muds were found to retard drilling and to be susceptible to gas-cutting. Thinning the mud and treating it speeded up operations and reduced the gas-cutting hazard. In this field the practice was adopted of using thin mud for drilling, and thickening it preparatory to running casing. One advantage of using the thinner mud was the reduction of wear and tear on the slush pumps by abrasive material carried in the mud.

An interesting fact is that a well finished in 59½ days in 1932, was a better and straighter hole than one completed earlier in 120 days.

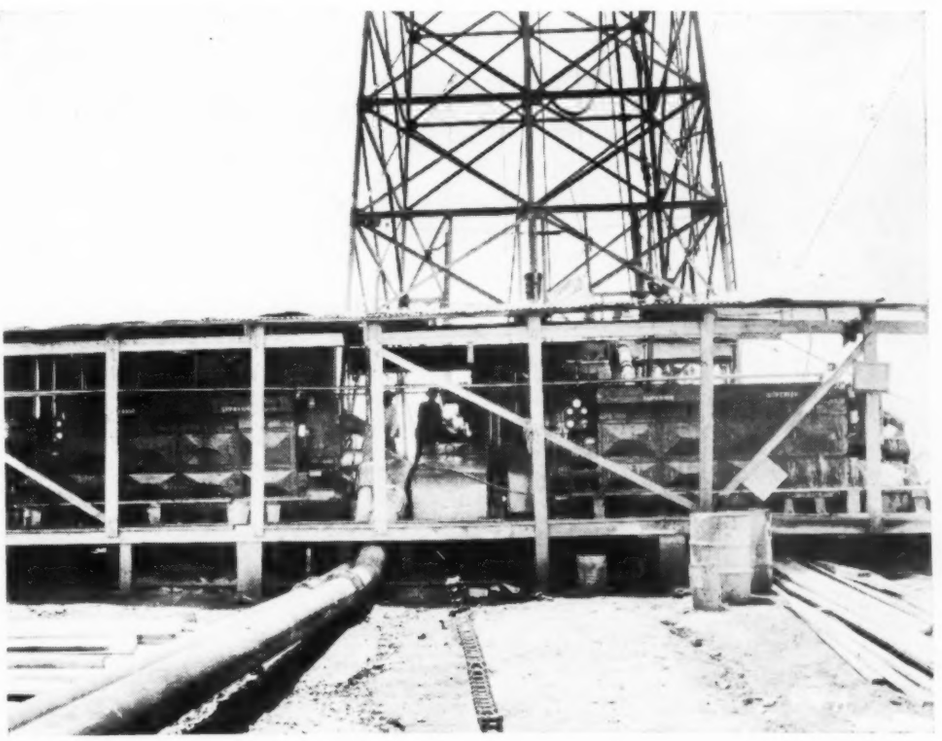
Steam-generating practices underwent a change in the development of this field. All boiler water was treated and as an economy measure the use of condensers for boiler feed water at wells was introduced. A reduction in shut-down time for boiler repairs resulted. High-pressure field boilers, 250-300 lb. working pressure, were also introduced in this field for drilling. These were lagged with asbestos, as were also the steam lines to the rig, in order to reduce condensation losses and have dry steam at the engine.

Standardization of boiler settings, feed pumps and auxiliaries were also introduced. These innovations in oil field drilling practice served to draw to the attention of operators in the Mid-Continent the many economies that were possible.

Concrete derrick foundations, with adequate concrete underground cellars for master control connections and a blowout preventer, were designed so that wells could be completed safely under the high-pressures found in the field. Concrete foundations are now standard in modern deep-drilling practice in the Mid-Continent.

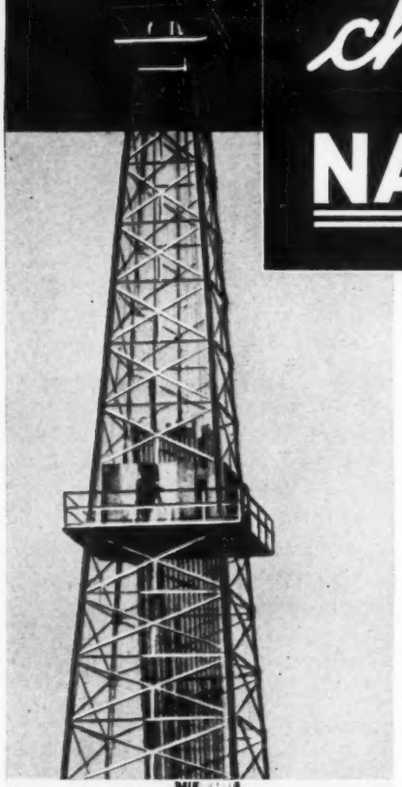
Reamers and long stiff joints on the bottom and rubber protectors at the tool joints of the drill stem are commonly used on deep wells. For reducing friction, wear on drill pipe and casing, and as guides in eliminating whipping of the drill pipe, the value of rubber protectors is recognized by Mid-Continent operators.

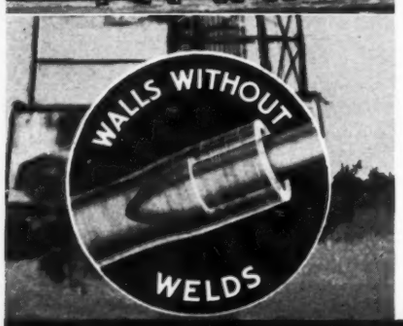
A typical casing program for the deep strings of wells in the Oklahoma City field, consists of 5500 ft. of 9-in. O.D. 40-lb. A.P.I. grade C casing and 6400 ft. of either 6⅝-in O.D. 24-lb. grade D or 6⅝-in O.D. 26-lb. A.P.I. grade C seamless casing.



View showing the Diesel engines used on a deep well in Oklahoma

Another world's record chalked up for NATIONAL CASING





Longest string of Casing ever run—10,301 feet of NATIONAL *Seamless Special Diamond B8 Casing—landed in the record running time of 18 hours without mishap.*

Once more, NATIONAL Casing makes a world's record, this time in Gulf Production Company's J. T. McElroy 103, Upton County, Texas—10,301 feet of 7-5/8" O.D. NATIONAL Seamless Special Diamond B8 Casing with long threads and couplings. As in the recent Denver Producing and Refining Company's well in Caddo County, Oklahoma—where NATIONAL Casing chalked up the previous world's casing record of 9,910 feet—once again established merit pointed to the source of tubular material.

No. 103 McElroy is 10,630 feet to the bottom. Casing was put down in actual running time of 18 hours. Noteworthy in this remarkable demonstration was the fact that this record depth was made with the regular long threads and couplings developed by National Tube Company and which gave perfect performance.

That new world's-record wells are equipped with NATIONAL is easily explained. When really hazardous work is contemplated, only pipe and casing of the highest dependability can be considered. And experienced operators know the qualities of NATIONAL Oil Country Tubular Products. Great strength, extraordinary toughness, exceptional ductility, superior threads, and unequalled all-round capability to meet the most rigid demands justify the continued preference for NATIONAL.

It is interesting to note that in the McElroy well, 10,700 feet of NATIONAL Special Alloy Drill Pipe was also used, establishing a new record for drill pipe in the West Texas area.

When the going is rough, when new depths and new problems are to be encountered, take no chances—specify NATIONAL—

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NATIONAL TUBE COMPANY · Pittsburgh, Pa.

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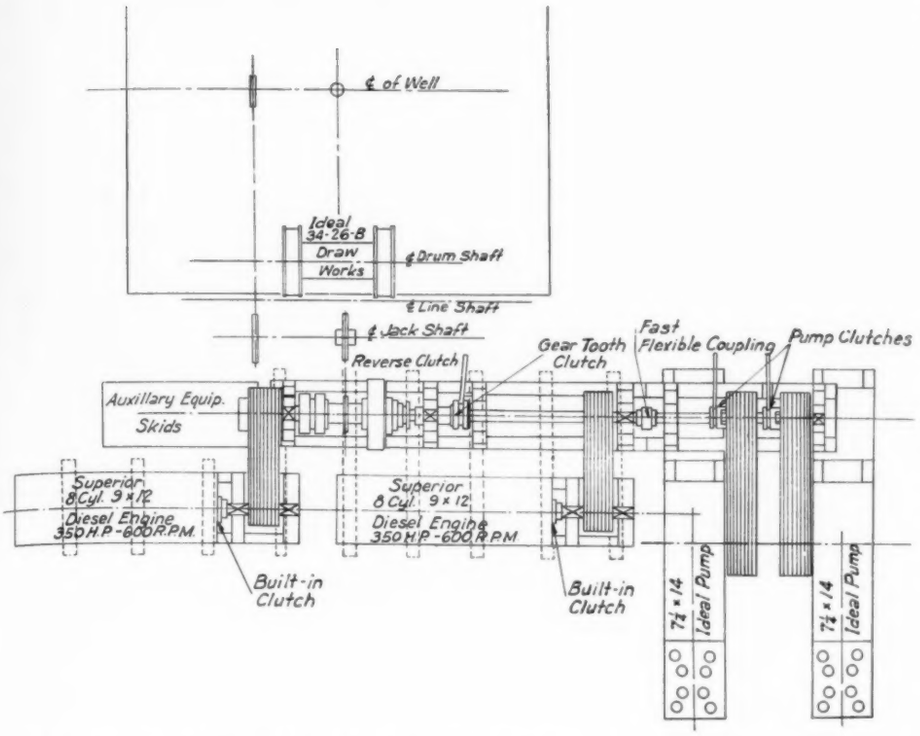

Layout of Diesel rotary rig used on a deep well in Oklahoma

Before running a long string of casing, all tight places in the hole are reamed. The mud is treated and thoroughly circulated to insure uniformity in the well and remove all cuttings or mud accumulation at the bottom of the hole. A cement guide shoe on the bottom and a cement float collar a few joints above the shoe are commonly used. Sometimes another float collar is used as an extra precautionary measure.

Extreme care is used in making up joints to see that threads are thoroughly cleaned. Discretion is used in running up joints with rope. It is the more common practice to start the thread by hand with a light tong and then spin it in with a rope off the cathead.

Almost all drilling in the Mid-Continent is done by contract. All drilling contracts for deep wells have a clause stipulating the limits of vertical deviation. The average limit is from 2 to 4 degrees. Usually wells are surveyed at 250-500 ft. intervals after a certain depth is reached.

Systematic coring is practiced in deep wells. Casing points are usually always determined by coring. Wells are also cored for markers. Care of coring tools is regarded by responsible operators as especially important in deep well operations. Both rock-bit and standard rotary core barrels are used. In coring, the condition of the mud and pressure on the bit are carefully watched. The core bit is run close to bottom, after which the mud is circulated for a few minutes to insure the removal of any cuttings on bottom. Most operators thin the mud if the well conditions will allow. Thin mud speeds up the circulation and hence the removal of the cuttings. If too thick, circulation is retarded and the cuttings are not carried off fast enough. When the hole is cleaned the bit is lowered to bottom. Cutting is then begun at slow speed, usually from 20 to 30 r.p.m., and with a light bit pressure. Circulation is maintained at a normal drilling rate while coring in hard formations. If the formation is very soft, the pump speed is reduced to guard against washing the core. When the required amount of core has been cut, the speed of rotation is increased before lifting the core barrel to assist in breaking the core off at bottom.

Responsible operators usually exercise the utmost care in coring deep wells. They realize that high recovery means fewer round trips and a lower cost per ft. of core. With the improved coring tools now available the technique of taking cores in deep wells is no different from that of taking cores in shallow wells.

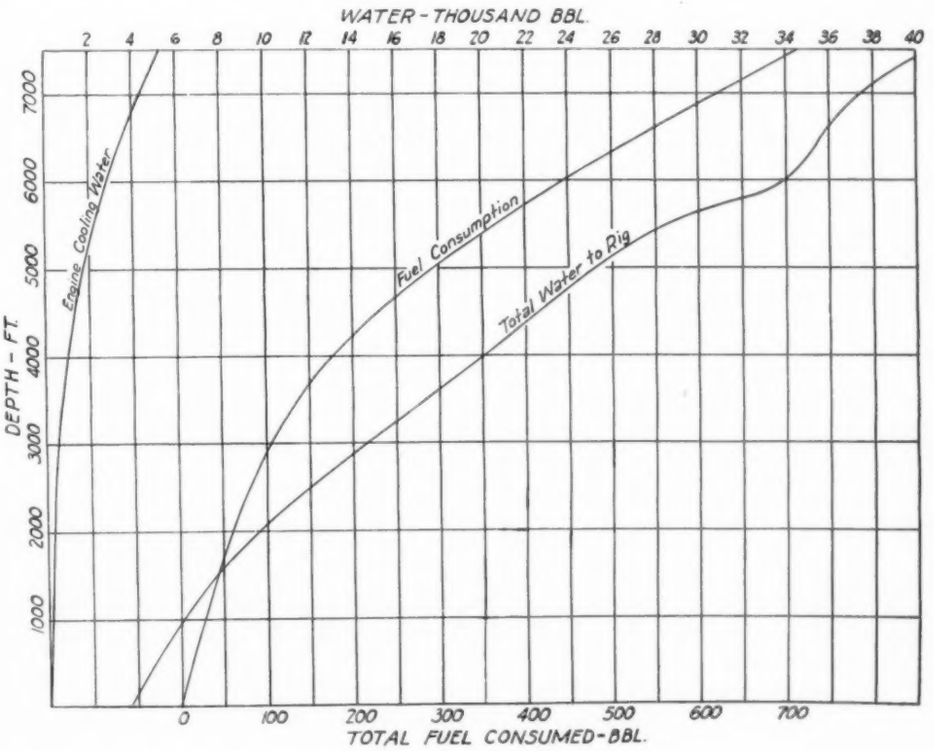
WATER - THOUSAND BBL.
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
DEPTH - FT.
1000 2000 3000 4000 5000 6000 7000
Engine Cooling Water
Fuel Consumption
Total Water to Rig
0 100 200 300 400 500 600 700
TOTAL FUEL CONSUMED - BBL.

Chart showing fuel and water consumption of Diesel rotary rig shown above

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Let's bring this Big Idea out in the open and have a complete understanding about DRILLABILITY, which is so important to *any* man who is in *any* way responsible for the successful setting of *any* string of casing.

Let's consider what happens after your string of casing is cemented in place and the internal plug must be drilled out, without danger of fracturing the new cement behind the casing.

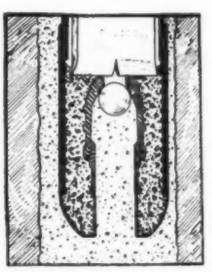
Baker provides complete Drillability by using a bakelite valve assembly imbedded vertically in Baker-Formula Concrete, so that only a small cross-section of bakelite is contacted by the drilling bit which rapidly and with minimum vibration drills both bakelite and concrete to small, harmless fragments.

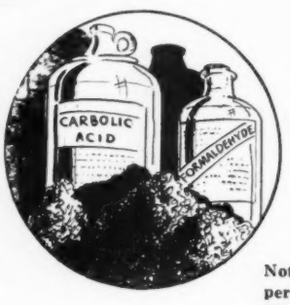
These small particles of bakelite and concrete then circulate out of the hole with rotary mud, and the bottom of the hole is left free from metal or other dangerous materials which interfere with drilling and coring immediately below the shoe.

Concrete mixed by the Baker Formula has more than three times the strength of ordinary concrete, under actual test withstanding more than 7,000 pounds compression per square inch. Yet it is easily ground up by the bit, and circulated out of the hole.

Baker offers you a better, safer way to guide, float and cement your casing, plus Drillability which is a Big Idea in securing a permanently profitable well.

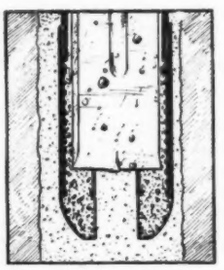
When the bit is applied to drill out the plug, you appreciate the Big Idea. Rapidly and with a minimum of vibration, the concrete and bakelite are drilled up into small, harmless fragments.





Bakelite is a resin-like substance formed when carbolic acid is treated with formaldehyde and combined with powdered wood flour. The resultant mixture is moulded according to Baker Specifications for heat and pressure, to provide a strong and efficient ball-valve assembly.

Notice the streamlined passageways which permit unrestricted circulation of cement. The buoyant bakelite ball, which floats in ordinary rotary mud, moves up the instant back-pressure occurs, to provide a leakproof double seal against rubber and bakelite.



As the bakelite and concrete are drilled out, the small particles circulate out of the hole with the rotary mud. No metal or other objectionable fragments are left in the hole. Baker Drillability leaves a hole ready for safe drilling, or immediate coring.

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Steam-driven rigs with conventional drawworks and rotary drives are in general use in the Mid-Continent. During the development of the Seminole field many Hild-electric drives came into use.

There is a demand among operators for fuel and water economy in drilling operations. These are two important items in wildcat drilling, or in areas where no natural gas fuel is available. As a result, several prime movers with mechanical drives have been introduced in the Mid-Continent fields. These include gasoline engine, Diesel engine, Diesel-electric and gasoline-electric rigs, and have been described in past issues of The Petroleum Engineer as they appeared in operation in the field. The most recent rig of this class was put into operation on a deep prospect well in Southern Oklahoma about four months ago. The rotary and drawworks are regular equipment, but the Diesel engines, and the mechanical drives to slush pumps rotary and drawworks are new.

The power end of this rig consists of two 350-hp. 8-cylinder, 9x12, 4-cycle full Diesel engines having a rated speed of 600 r.p.m. with compression and firing pressures of 400 lb. and 600 lb. respectively. They actually develop 440 hp. at 600 r.p.m. and have an operating speed range of 250 to 600 r.p.m. These engines have a full injection system whereby the engine is enabled to develop high torque at low speed, a very desirable characteristic when pulling pipe and one that is common only to steam prime movers. Twin Disc clutches, fully enclosed, are built into the engines.

The mechanical drive has an A-700 Ideal reverse gear of planetary type mounted on a 7½-in. shaft running in roller bearings. This reverse gear has air-operated controls; these are operated from the driller's position. A manual control is also provided. The countershaft, which can be connected to the reverse gear shaft by a special gear tooth clutch, is connected on one end to the pump countershaft by a 700-hp. Fast flexible coupling. Two jaw clutches on the pump countershaft permits the use of either pump or both pumps as desired.

V-belts transmit power from the engines to the reverse gear shaft and countershaft.

Flexibility characterizes this mechanical drive. Under normal drilling duty one engine drives the rotary and the other the slush pump. When pulling pipe both engines are used for hoisting by disengaging the pump clutches and engaging the special gear tooth clutch between the countershaft and the reverse gear. Thus the engines may be used singly or together to drive either the drawworks or the slush pumps.

Curves of the fuel and water consumption are shown on the accompanying chart.

With this rig, a 5600-ft. string of 6⅝-in. drill was pulled in two hours and ten minutes. Running the pipe back into the hole took one hour and 50 minutes; also a string of 9⅝-in. 42-lb. casing was landed at 5870 ft. with one engine, with eight lines in the traveling block.

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Deep-Well Cementing Practice

Cementing long strings of casing is one of the most important phases of deep-well drilling and one in which the procedure is fairly well standardized.

The circulation two-plug method is the most widely used. When a long string of casing is to be run, the hole is first prepared by thoroughly circulating with the mud to clean the bottom of the hole of any deposit of heavy mud, silt or cuttings that might contaminate the cement.

In mixing the cement, the water-cement ratio is closely controlled. The amount of water used may vary from a minimum of 3½ gal. or less to a maximum of five or six gal. per sack of cement. Well conditions determine the water-cement ratio that should be employed. It is kept as low as the well conditions will allow. A uniform water-cement ratio throughout the mixing operation is desirable for a successful cementing job. Good operators know this and make an effort to get as uniform a mix as possible.

In a well with a high circulating pressure and heavy mud the use of a high water-cement ratio is usually necessary in order to place the cement behind the casing.

Float equipment sufficiently strong to stand the pressure and yet easy to drill out are required in running casing in a deep hole. On very long strings it is good practice to use a cement guide shoe on bottom and two float collars, each a joint above the other, several joints above the shoe.

When estimates are made of the amount of cement required, due allowance is made for leaving some cement in the casing. Some companies estimate about ten ft. per 1000 ft. of casing in the hole as the amount of cement that should be left in the casing. This allowance is made to ensure having good clean cement around the casing shoe. Mud, if present, will render the cement soft and keep it from setting.

The amount of cement used to set the long casing string in the well is determined from well conditions and may vary from a few hundred to two or three thousand sacks.

In high-pressure areas the casing is run through control fittings, usually a control head and blow-out preventer. To check the final position of the cement plug a steel measuring line is run on top of the top, or follow-up plug. Sometimes, the position of the plug is determined by measuring the amount of fluid pumped in on top of the plug. This method has to be used with caution, for the presence of a small amount of gas in the fluid will increase its volume, and hence its displacement, in the casing.

After the cement is in place the well is closed in and the final pump pressure held constant for 24 or 48 hours. Sometimes the well temperature, augmented by the temperature developed during the setting of the cement, will expand the fluid in the casing and cause an increase in pressure. Should this happen, a steady pressure is maintained by releasing fluid from the casing.

New deep-well cementing processes have been developed recently. Three of these are of outstanding merit and are each an advancement in the art of cementing.

By the first of these three processes, a combination string of casing with a screen the same size as the casing, can be set and cemented. Provision is made for washing the screen perforations.

The second of these is the multiple-stage cementing process developed in the Mid-Continent. By placing the cement in two batches, in one continuous operation, high pressures are avoided. One batch of cement is pumped around the shoe, and the other batch through a special cementing device in the string of casing.

The third of these processes, which has been developed and used with success in California, permits cementing off intermediate water-bearing strata. This process was described in last month's issue of The Petroleum Engineer.

Deep-Well Drilling Under Pressure Control

By E. V. FORAN

During the last two years a system of drilling-in wells under pressure control has been developed by the Big Lake Company in the Big Lake field, West Texas.

Several high-pressure producing horizons are found in this field at a depth below 8000 feet. Variations in pressure and productivity of the producing formations gave rise to difficulties while drilling-in. In the first deep wells in the field, which were drilled and completed by conventional rotary methods, it was found that the high hydrostatic pressure of the column of mud fluid resulted in mudding off the producing formations and caused doubt regarding their productivity. The low-pressure formations, which are cavernous limestone, are found to be very susceptible to mud penetration.

It was evident that modification of the drilling-in method was necessary to overcome this mudding hazard, which was quite a serious one in these deep wells. This presented certain difficulties, the greatest of which was that the high formation pressure made it dangerous to use a light drilling fluid, because the hazard of a blow-out was too great. Obviously, weighting the mud would increase the mudding-off hazard.

Some other means had to be found to prevent mudding-off the formations and still keep control of the well while drilling-in. Finally, the hydraulic pressure control method was decided on and adopted. The process has been in use during the last two years by the Big Lake Oil Company and has been gradually improved during that time.

Briefly, it consists of controlling the pressure at the bottom

of the hole by holding back-pressure at the surface on the return line of the circulation system. The process is used only while drilling-in the well.

After the 7-in. casing is set and cemented in top of the lime at 8200-8300 ft., the regular rotary is replaced by the hydraulic pressure equipment, which consists of a hydraulic table and snubbers, automatic slips, pressure drilling head, small steam-driven water pump for operating the hydraulic table and pull-down yoke, an 8-ft. steel substructure of 500 tons, a complete string of 3½-in. O.D. 13.3-lb. flush-oint drill pipe.

The plug is first drilled out and the well deepened about 200 ft. into the limestone. At this depth, or when the productive part of the limestone is reached, the drilling fluid, which is clear water, is unloaded from the well. The drill pipe being securely packed off permits controlling the pressure on the return circulation fluid column. This is done by means of chokes on the return line.

On the first wells drilled-in under pressure control the oil, gas, water and cuttings were passed through a high-pressure separator, from which the gas was passed off through a vent to atmosphere and the oil run to the stock tanks. The water and cuttings were drawn from the separator continuously and piped to the circulating pit.

Before unloading the drilling fluid, the circulating pump pressure was 1300-1500 lb., but after unloading, a circulating pump pressure of only 1000-1100 lb. was required to handle the same quantity of water. This difference was due to lightening of the return column of drilling fluid by gas from the producing formulation. A back pressure of 250-400 lb. was held on the circulating return line.

A gas zone having a pressure of only 1900 lb. has to be drilled through in these deep wells. The pressure of an 8000-ft. column of clear water obviously is much too great to allow the sand to be tested. This difficulty was overcome by injecting gas into the drilling water at the surface. In order to get a water-gas fluid of the proper weight about 800 cu. ft. of gas per bbl. of water was injected. With this ratio a pressure of about 1900 lb. was obtained at the bottom of the hole. When circulating with gas, about 125 bbl. of water an hour was used. The amount of gas circulated in this manner was not constant. It had to be changed according to the volume and pressure of the formation gas as drilling-in progressed.

Gas is no longer used as a means of lightening up the fluid column. Its use is not necessary, for it has been discovered that by using oil as a circulating fluid a bottom-hole pressure sufficiently low can be maintained while drilling-in the low pressure sands in the deep wells. When the well begins to produce gas and oil in sufficient quantity, a return is made at once to water as a drilling fluid. No change is made in the rate of circulation when oil is used. It averages 200-250 bbl. an hour. Two 500-bbl. tanks are used for circulating oil. The circulating returns flow directly into one of the tanks while the circulating pump draws from the other. Heavy oil is used for circulating. The cuttings settle in the tank, where they are allowed to remain until the well is completed.

By drilling-in under pressure control several advantages are gained: The mudding-off hazard is eliminated; accurate measurements of oil and gas production can be obtained; changes in the productivity of the well and the particular producing characteristics of the formation are disclosed; by using oil as a drilling fluid, low-pressure productive formations in deep wells will not be overlooked; blow-outs hazards are eliminated, for the well can be kept continuously under control while drilling-in, even under the most adverse conditions.

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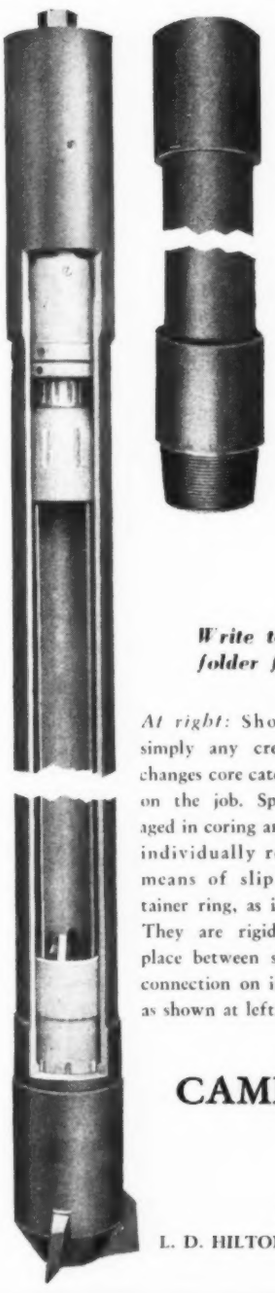

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Deep-Well Drilling in California ...Methods and Equipment In Use

By
WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

A central mud reclamation plant at Ventura, California

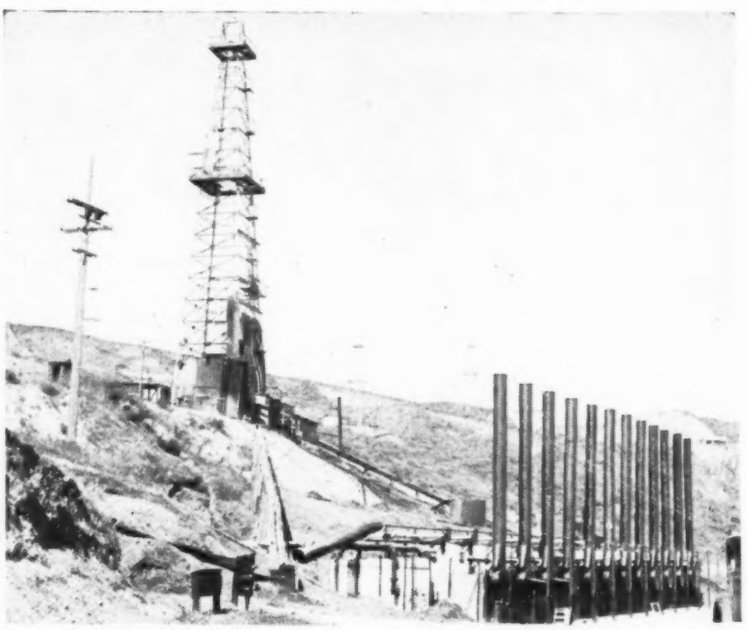
DEEP wells in California are where "Men, Methods and Machinery Meet." This has been especially true during the past year or two when the application of the most advanced methods by drilling crews in close cooperation with the management and technical staffs has demonstrated that the present design of equipment is adaptable to drilling below 10,000 feet. Considering deep wells in California as being those of 8000 ft. or more in depth, the number of such wells supplies a considerable portion of the state's oil production. These deep wells are, therefore, definite factors in many development programs and must be put down efficiently and economically. They have naturally contributed to present-day drilling technique.

The drilling of deep wells has not, of course, given rise to any set of rules either for operating methods or for equipment. Conditions are far too different in different fields to establish even general programs; and the individual experience of operators is naturally applied to the determination of methods as well as to the selection of equipment. The heaviest equipment available is not always used; and some of the wells that have reached depths below 10,000 ft. were drilled with equipment that had been on the market for five or six years. The general tendency, however, is to use the most advanced designs available and to take advantage of every aid that can add to drilling control.

Making Hole

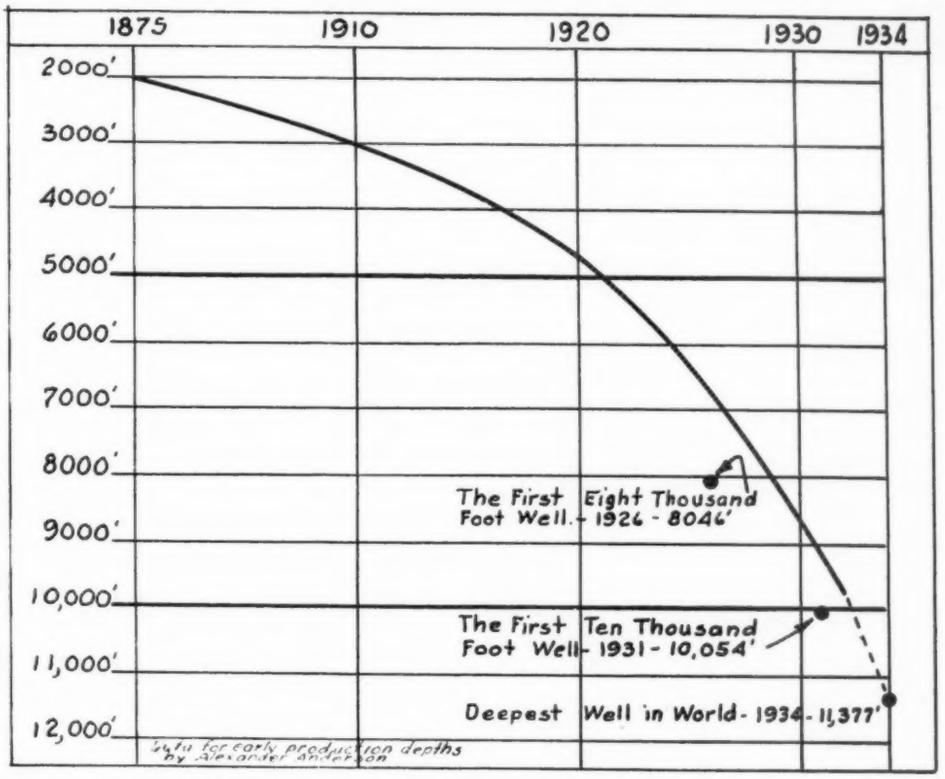
Bits of all kinds and styles and shapes are used in various formations; and with marked success. Both experience and the results of extensive tests have governed the selection of bits, and the use of hard-facing and diamond-hard material or inserts is now practically universal. The fishtail is extensively used for the top and sandy formations. Disc bits and special bits with multiple wings, serrated teeth, removable blades, and other patented features have been found very effective in from soft to medium hard formations. Rock bits are widely used in hard formations. Some of the deeper formations, such as encountered in the world's deepest well in the South Belridge field, are extremely hard and slow up the progress of any type bit that has yet been devised.

Drill pipe used in drilling the deep wells ranges in size from 8⅝-in. down to 4½-inch. One organization drilling in Kettleman Hills never runs any drill pipe larger than 6⅝-in. and completes the last 1000 ft. or more with 4½-inch. Flush-joint drill pipe has been used to advantage in providing a means for getting the greatest amount of mud possible to the bottom during deep drilling. Sometimes the bottom part



A battery of boilers supplying steam power to several drilling wells—a not uncommon practice in California

Approximate depths of wells in California

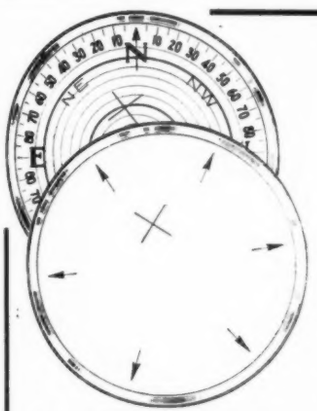


of the string is flush joint, and the rest interior upset. Flush-joint drill pipe is also used by some operators more extensively. Up to about two years ago, Grade D drill pipe was not widely used, but the tendency now seems to be to utilize the additional strength provided by the Grade D pipe.

Coring has become a definite part of drilling operations and the success attending the recovery of cores at great depths has aided materially in obtaining geological data and in the completion of wells. The taking of a practically perfect core at 11,322 ft. has demonstrated that deep-coring can be done with rotary core barrels. The percentage in core recovery has also increased, although the character of the formation will naturally influence core recovery. Circulation is a big factor in deep-coring and the core barrel should provide the greatest circulation possible, preferably greater than that provided by the drilling bit. Large diameter cores are advantageous, since they give greater columnar strength and the greatest difficulty in getting good cores in deep wells lies in the fact that the hole is often reduced to rather small size during the drilling of the last 1000 ft. or so.

Drilling Fluid

Mud is quite a problem in some of the California fields. At several localities it has to be hauled in trucks, either in



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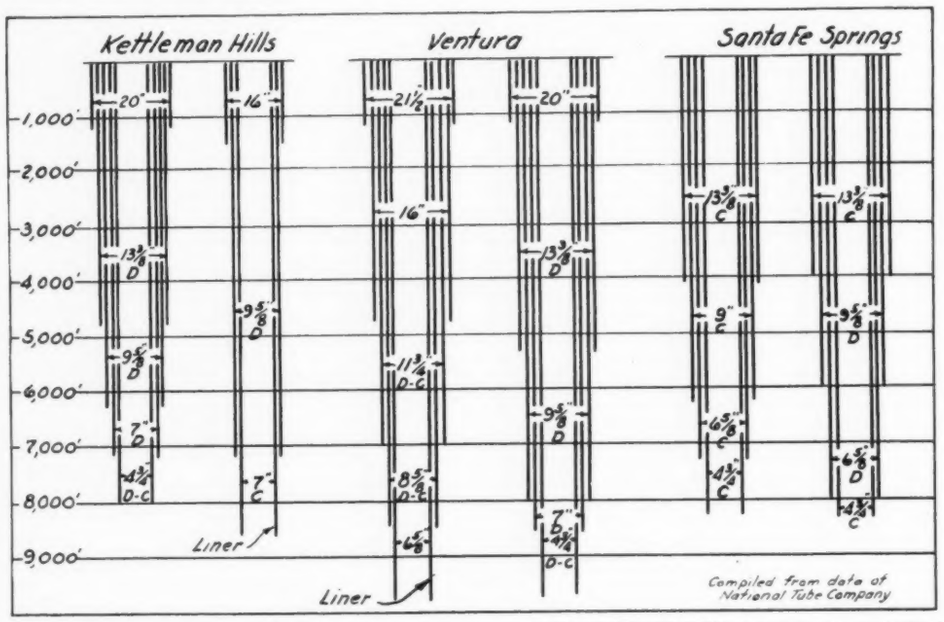
liquid form or pulverized ready for mixing; and the distance this prepared mud is transported is in some cases as great as a hundred miles. In other fields, the clay available is of poor quality and admixtures giving it colloidal properties have to be added for most of the entire depth.

The weight carried varies from 65 to 100 lb., the average for general conditions being from 75 to 80 lb. per cu. foot. In wells where very high pressures must be overcome, the mud fluid may be as heavy as 115-120 pounds. All special conditions are taken care of by the addition of weight materials, chemicals or colloidals. During the past year there has been an increased use of chemicals for handling heaving shale and to recover lost circulation.

The mud is circulated on the surface through flumes that are approximately 100 ft. long and having a drop of about 3 ft. in this distance. Vibrating screens have come into extensive use and have been found especially valuable where mud is scarce. Mud weight control is being given more attention, and on some of the late wells special apparatus has been installed to measure the weight of the drilling fluid at all times and to determine its consistency, sediment content and rate of settling.

Even the disposal of the mud is sometimes a problem. The vibrating screens assist here and reclamation projects not only cut down the volume of waste but also eliminate a considerable amount of replacement when the supply is not readily available. The central plant system that has been in operation for several years at Ventura has been found very effective. The centrifugal method of reclamation is also used, but little application of the chem-



General casing programs for deep wells used in three fields in California. Programs in other fields vary to meet the different field conditions

WHEN YOU COMPLETE THAT DEEP HIGH PRESSURE WELL

Equip it with

OTIS REMOVABLE

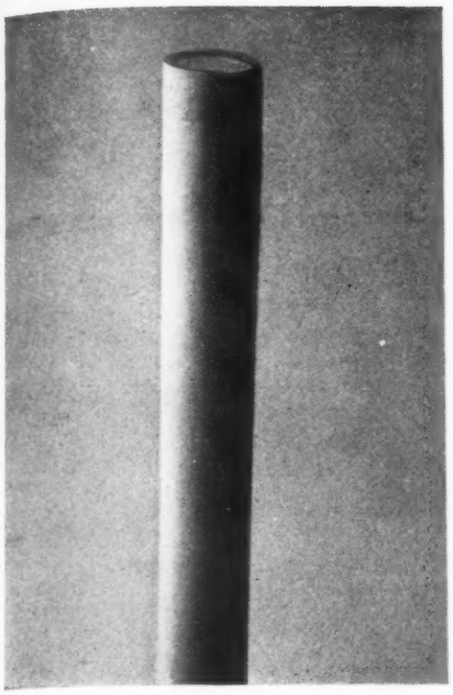
BOTTOM HOLE CHOKE

To completely eliminate high surface working pressure and freezing.

THE SOUTHERN STATES COMPANY, Inc.

Tower Petroleum Bldg. . . . Dallas, Texas

Also a complete service for the running and pulling of tubing under pressure (patented). More details of our services will be found on page 478 of the 1934 Composite Catalog.



This core was taken in a well (rotary) in California at a depth below 10,000 feet

icals strictly for mud-conditioning has yet been made. With the greater amount of deep drilling and the necessity for mud control, considerable advancement can be expected.

Keeping Holes Straight

A great deal of experimental work has been done in the past year or two by several of the large companies on the effect of various factors that, by being governed, will combine straight hole drilling with greater speed, less wear on subsurface equipment, and less maintenance on surface machinery. The use of tachometers, torque gauges and mud pressure gauges has been discussed in a previous article in The Petroleum Engineer. Besides the drilling control obtained by these instruments, however, the individual operators adopt mechanical methods that, according to their judgment, helps keep the hole straight. A straight hole is of particular importance in deep wells and among the methods employed are the use of large size drill pipe, reamers above or below the drill collar, lighter bit pressure, higher speed of rotation, etc.

Periodic surveys provide information that will enable the operator to correct any deviation of the hole before it gets serious. Some companies survey for amount of deviation only but there is a growing tendency to survey for both direction and deviation at regular intervals.

The weight being carried on the bit is watched very closely. This varies with different companies but since the tendency on the part of a number of operators to increase the speed of rotation, the weight specifications have been altered. With the average old speed of rotation, which frequently ranged from 50 to 75 r.p.m., the weight carried on the bit would be held at some point between 5500 and 12,000 pounds. This weight has necessarily been decreased considerably as determined by the experimental work with the higher rotating speeds. While little data are yet available, the weight to be carried with speeds up to 150 r.p.m. will probably vary from 5000 to 7500 pounds. Conditions and the factors involved in the specific methods of operation used will naturally influence the weight to be carried; and the personal judgment of engineers and superintendents as based on both experience and tests will probably have considerable to do with the establishment of a policy for each company.

Automatic control in connection with the drawworks of both electric- and steam-powered rigs has also helped in straight hole drilling. Instruments are being widely used, especially on the very deep wells, and while these are merely guides for manual control, there is no reason why the regulation of rotating speed (already being done), torque and pump pressure cannot be made automatic with definite coordination of the various factors.

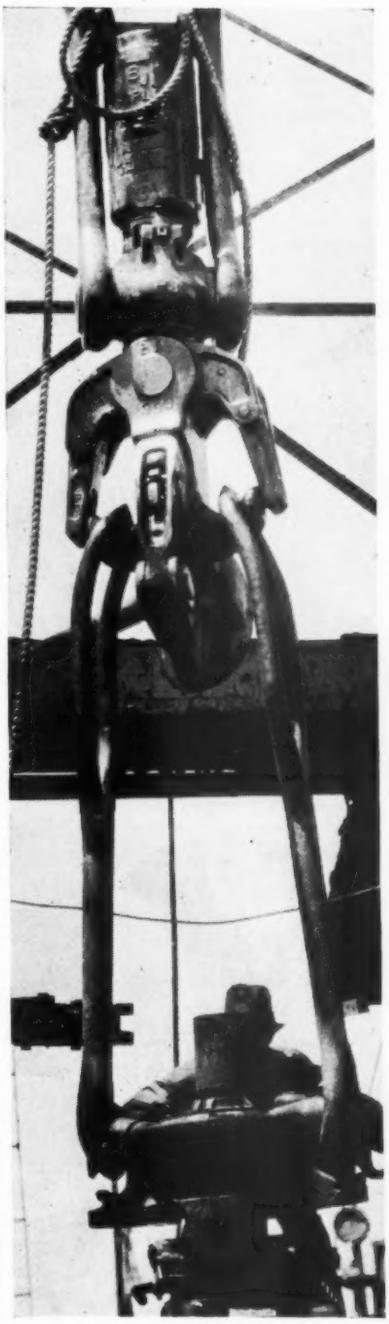
Sub-Surface Equipment

The general casing programs for some of the deep California fields are shown graphically in an accompanying illustration. Wildcat or semi-wildcat wells cannot follow any specific program as determined by similar conditions. Yet the geological features of certain areas provide sufficient information to make the casing programs of such wells surprisingly effective.

It will be noted that the factor of safety for both collapse and tension is very small for the length of casing strings as shown. This is true for the collapsing strength of all the strings and for the tensile strength of the very long strings. The amount of cement placed behind the casing, however, usually reduces the effective hydrostatic head to a point where the maximum pressure causing collapse is lowered until the factor of safety is above two. The strain in tension is even less likely to be dangerous, since the casing strings are floated in. For deep wells it is the practice to equip the string with a guide shoe at the bottom with a float collar one joint above this and a second float collar one joint above the first.

Slip-joint casing is used for surface strings exclusively by one organization in the Kettleman Hills field, but this string is either 20-in. or 16-in. in diameter. Both Grade C and Grade D casing are used and are, in general, as shown on the drawing. Most perforations of strings used as liners are made in Grade C sections at the bottom although there seems to be no definite practice in liner procedure. Flush-joint casing has been used both in the liner strings and in other casing strings, and present indications are that a greater use of flush-joint casing can be expected for the deeper wells. The matter of clearance is an especially important factor in very deep wells, and in wildcats greater than 10,000 ft. in depth may become a serious problem.

Hooks and elevators in use on deep wells handle heavy loads with ease, even on the deepest wells



This ADJUSTABLE GUIDE HEAD

. . . has long been needed in a Tubing Spider

The adjustable guide head of the new Guiberson Tubing Spider renders it no longer necessary for the operator to force the slips into the Spider bowl to properly align the tubing. The guide head aligns the tubing in the center of the bore of the Spider and at the same time acts as a guide for the tubing and a stop for the slips. This improvement has long been needed, for the efficient handling of tubing.

The guide head on the Heavy Type Spider, here shown, is in two pieces, head and collar. When running 2" or 2½" tubing the guide collar is used, and by removing the collar 3" and 4" tubing can be run direct in the guide head. On the Light Type Spider the guide head is in one piece and will accomodate 2", 2½" and 3" tubing.

Ask for folder fully describing the advantages of this new, improved Spider.

THE GUIBERSON CORPORATION
Box 1106, Dallas, Texas
LOS ANGELES: 1304 Security Title Ins. Bldg.
TULSA: 504 Wright Bldg.
NEWARK, OHIO: First and Locust Sts.

GUIBERSON
BETTER BE SAFE THAN SORRY

Deep cementing has not presented so much of a problem in the last few years. Considerable attention is being given to water-cement ratios and the use of reagents is probably less than formerly. The high temperature encountered in deep holes is frequently beneficial when the initial set of the cement is low. Cementing off intermediate water by the multiple-stage method with special equipment has been discussed in a previous article. The average casing cementing job is done by standard methods as developed by the various cementing companies.

Surface Equipment

The 136-ft. derrick with 26-ft. x 26-ft. base has practically become standard for deep wells. One 178-ft. derrick has been used in Ventura and holds the record as being the highest in the world. The advantages of the greater height and floor space provided by its 32-ft. base have been debated pro and con, but to date this one is the only derrick of its height yet installed in a California field.

Standard ends have usually been provided for rigs used on the deep wells but there is evidence of a trend toward eliminating all parts that heretofore have been installed for production purposes only. This is an economy measure entirely, but with wells drilled to 8000 ft. or more, the expectations are that they will flow for a considerable length of time. It is felt that any production equipment can better be installed when the time comes. The advancement in portable hoists and drawworks may be a factor in this practice.

Drawworks have, for the most part, been of the four-speed type, which superseded the three-speed type formerly used. Some of the six-speed type have been used on a number of the deep wells but it is still uncertain how popular these will become.

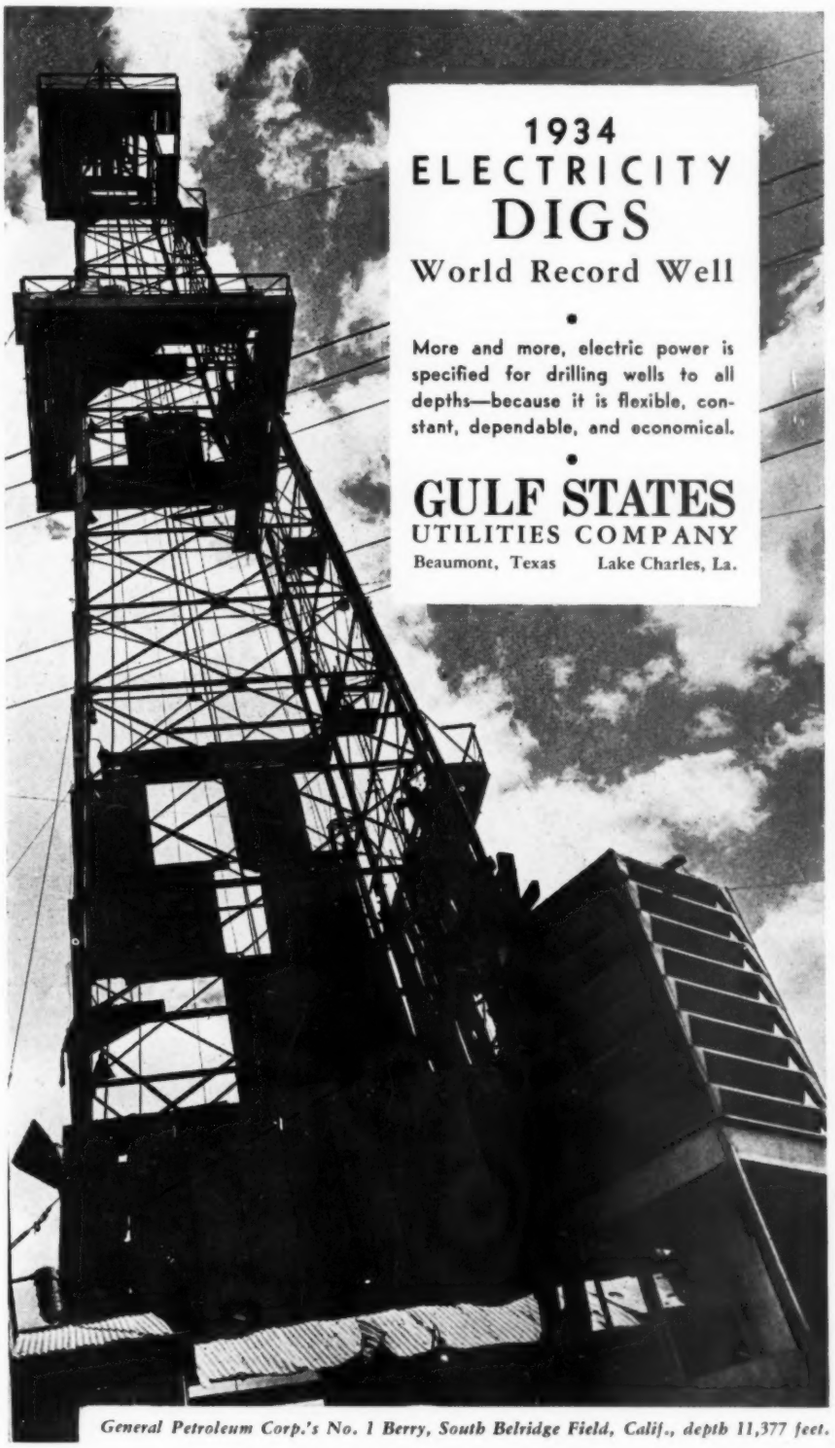
Other rig equipment varies in design and size with the individual selection of the operator. The majority of the crown blocks in use on deep wells are of the double-deck design. Almost all the traveling blocks are of the five-sheave type, those most popular being the 54-in. to 76-in. sizes. Both safety and strength are factors in hook design, and while the 125-ton swivel is in general use, a number of 150-ton swivels have been employed.

Both steel and rubber hose are being used. Where high pressures are expected and sand conditions permit, the steel hose is favored. In Kettleman Hills, some of the companies drill through a sandy formation at 5000 ft. with rubber hose and then switch to an all-steel hose.

While some 1⅛-in. wire line is used in drilling deep wells in California, the 1-in. Grade J has been found to have definite advantages. It has been the practice to increase the number of lines rather than use a larger diameter line. Moreover, most of the equipment is designed for 1-in. lines. One operating company asserts that when the loads are heavy lines with a steel center give better service because of their greater ability to retain their roundness and diameter, with an accompanying smoother spooling.

Virtually the majority of the steam prime movers now in use are 21-in. x 12-in. twin engines. The three-cylinder vertical has also been used, and a new vertical engine recently introduced has been installed on several wells in both Kettleman Hills and Ventura fields. When electricity is used for power, the total power rating of the motors for the drawworks and table is usually from 125 to 150 horsepower. A popular installation is two 25/65-hp. motors.

For deep wells the custom is to install two or three mud pumps. The sizes in general favor are from 12x6¾x12 up to 14½x7¼x20. The working pressures on the pump end are either 1500 lb. or 3000 lb. and 250 to 350 lb. on the steam end. When high pressures are expected, either one or two of the pumps are for 3000-lb. working pressure, but in a number


1934
ELECTRICITY
DIGS
World Record Well
More and more, electric power is specified for drilling wells to all depths—because it is flexible, constant, dependable, and economical.
GULF STATES
UTILITIES COMPANY
Beaumont, Texas Lake Charles, La.

General Petroleum Corp.'s No. 1 Berry, South Belridge Field, Calif., depth 11,377 feet.

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***Stronger* CHAIN TONGS**

Standard or Reversible Jaws

DESIGNS that give increased bearing of jaws on the bar. Chains that are proof-tested to two-thirds catalog strength (3,600 to 40,000 lbs.). Special steels for each part. Drop-forgings, accurately machined, heat-treated, hardened, tempered and tested. All of these features combine to make ARMSTRONG BROS. TONGS strong, longer wearing, finer tools in every way. All standard types. Sizes for all pipe from 1/8 in. to 18 in.

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"The Tool Holder People"

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Mid-Continent Representative:

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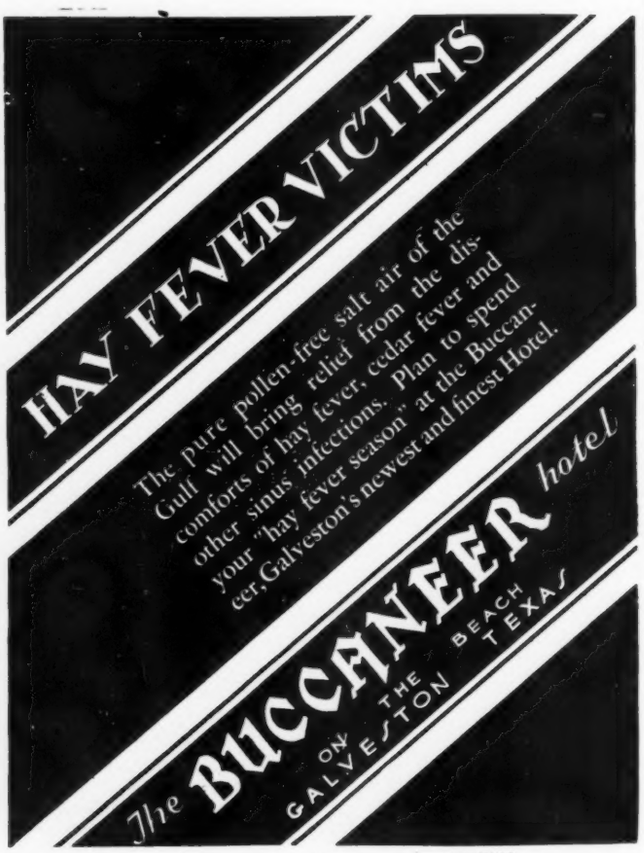
HAY FEVER VICTIMS
The pure pollen-free salt air of the Gulf will bring relief from the discomforts of hay fever, cedar fever and other sinus infections. Plan to spend your "hay fever season" at the Buccaneer, Galveston's newest and finest Hotel.
The BUCCANEER hotel
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GALVESTON TEXAS

of cases the pumps have been compounded to get the necessary pressure.

Since many fields have plenty of natural gas and water available, steam has been widely used for power. Probably half the boilers used up to the present time are of the locomotive type and in size average from 85 to 90 horsepower. In Kettleman Hills, the boilers are rated at from 100 to 125 hp. and 225 to 250 lb. working pressure. The actual pressures used, however, are often much lower.

The average boiler installation consists of four or five, one of which is installed as a stand-by. In some places, a battery of from eight to ten boilers is set up to supply steam for several wells.

Superheaters are generally a part of the boiler installation, and within the past few years have been used very extensively. Some operators also use preheaters for the feed water in addition to the superheaters.

Foundations

In addition to the permanent types of foundations, there have been several of the removable type used in the California fields. In Kettleman Hills, the topography has made it possible to construct the cellars virtually on top of the ground. Due to the hilly surface of the land the derrick floor is built above ground with whatever side-hill cutting is required, making but little excavating necessary. Foundations are of steel and concrete, and the design fits in economically with the topography. The main purpose of this type of foundation is to provide for the installation of the Christmas tree below the derrick floor upon the completion of the well.

In Ventura, one company constructs the rig foundation with as much structural steel as possible in order to provide a salvageable cellar. The engine rests on a concrete block built on the ground and independent of the rest of the rig.

Several other types of deep well foundation construction involve special features that are of particular interest to certain conditions that are found in California alone. Foundation design, however, is being given continuous study with the aim of obtaining economy and providing the greatest convenience during the drilling and production of the well.

Foreign Speakers on A.I.M.E. Program

Two papers of unusual interest, to be presented by foreign technologists, are to occupy prominent positions on the program of the annual fall meeting of the American Institute of Mining and Metallurgical Engineers in Tulsa, Oklahoma, October 12 and 13.

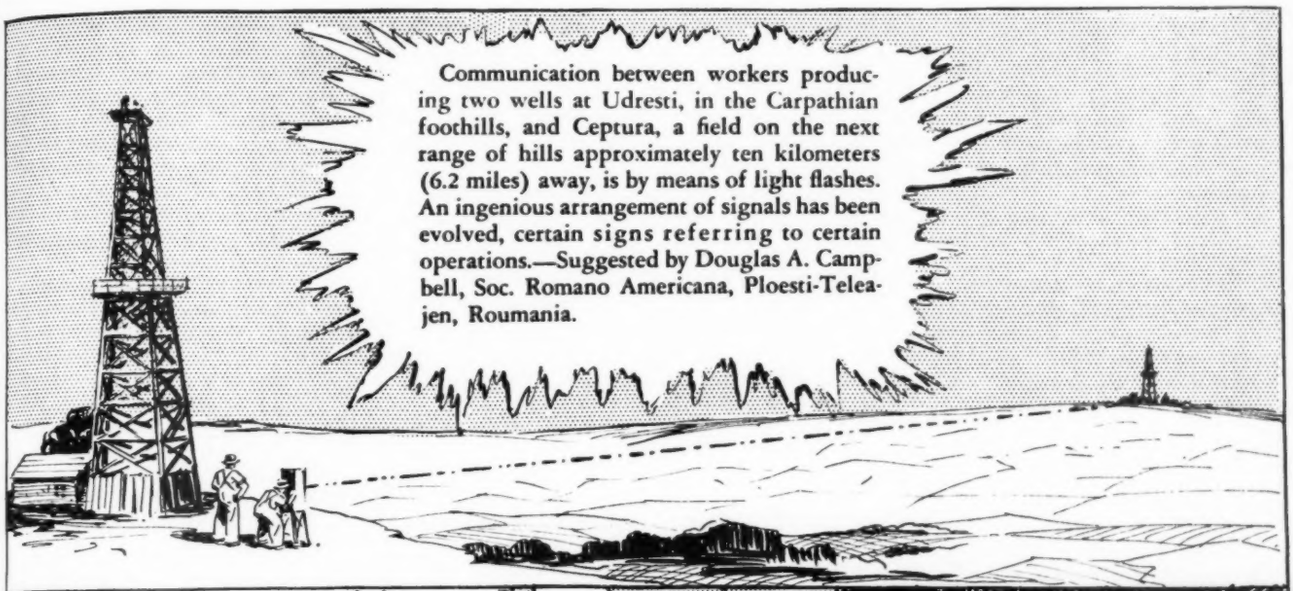
Dr. J. Versluys, professor at the University of Amsterdam, Netherlands, who will present a technical discussion of "Energy Relationships in Oil Bearing Formations," already is well known to petroleum engineers of the world, and his analytical treatment of the subject makes the paper particularly valuable at this time, according to H. H. Power, chief production engineer of the Gypsy Oil Company, Tulsa, Oklahoma, who is chairman of the production engineering committee.

Although not so well known in this country as Dr. Versluys, Dr. Cecil May of the Anglo-Persian Oil Company, Ltd., London, England, is one of the foremost petroleum technologists of Europe with a wide experience in the varied production problems on the scattered leases of his company in the Far East. His paper bears the title, "The Efficiencies of Flowing Wells."

Both of these papers will be presented on the first day.

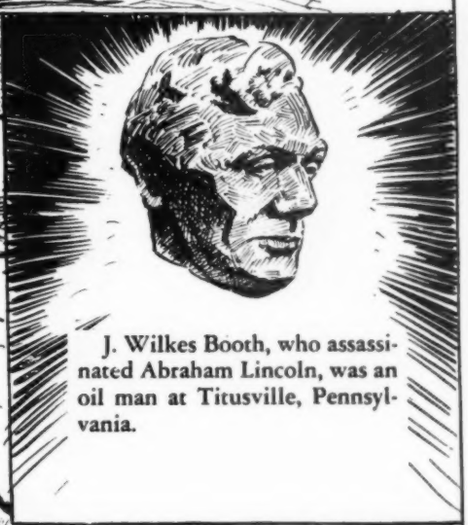
STRANGE.... *but* TRUE

HAPPENINGS IN THE PETROLEUM INDUSTRY

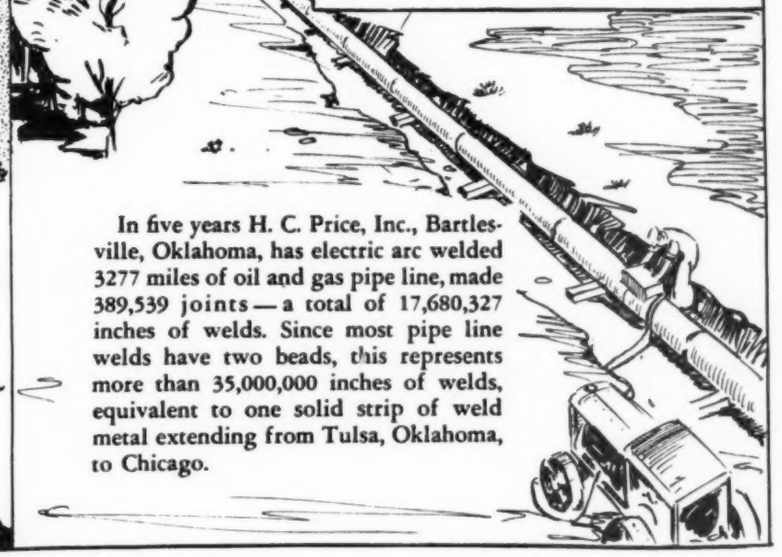


Communication between workers producing two wells at Udresti, in the Carpathian foothills, and Ceptura, a field on the next range of hills approximately ten kilometers (6.2 miles) away, is by means of light flashes. An ingenious arrangement of signals has been evolved, certain signs referring to certain operations.—Suggested by Douglas A. Campbell, Soc. Romano Americana, Ploesti-Teleajen, Roumania.

The Greeks once destroyed a Scythian fleet by pouring blazing oil on the sea. It was called "Greek Fire."



J. Wilkes Booth, who assassinated Abraham Lincoln, was an oil man at Titusville, Pennsylvania.



In five years H. C. Price, Inc., Bartlesville, Oklahoma, has electric arc welded 3277 miles of oil and gas pipe line, made 389,539 joints — a total of 17,680,327 inches of welds. Since most pipe line welds have two beads, this represents more than 35,000,000 inches of welds, equivalent to one solid strip of weld metal extending from Tulsa, Oklahoma, to Chicago.

STRAIGHT TO THE POINT

EXIT WASTE

When good lubrication goes in, waste goes out! Poor lubrication wastes countless thousands of dollars annually by increasing power costs, hastening the replacement of expensive machinery and slowing down production.

Power that is used in overcoming friction is worse than wasted because it is working against you. Proper lubrication converts the power you pay for into useful energy.

Thousands of factories in every line of industry are combating waste with Magnolia and Gargoyle Lubricants. The savings range from a few dollars to thousands annually. It will pay you to check up now.

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A Socony-Vacuum Company

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WHOLESALE AGENCIES AND STOCKS THROUGHOUT TEXAS, OKLAHOMA, ARKANSAS, LOUISIANA, AND NEW MEXICO.

F. C. Ripley, Jr., to South America for Continental-Emsco

F. C. Ripley, Jr., formerly with Emsco Derrick and Equipment Company of Los Angeles, California, recently was appointed South American representative, specializing on Emsco, D+B, and Gardner-Denver equipment, for Continental-Emsco Company, Inc., of New York City.

F. C. RIPLEY, JR.

Ripley left Los Angeles August 11 to visit the D+B plant at Dallas, Texas, the Gardner-Denver plant at Quincy, Illinois, the Youngstown Sheet and Tube Company's plant at Youngstown, Ohio, and the World's Fair in Chicago, before going on to New York, where he will stay a few days at the main office of the company before proceeding to South America to establish permanent headquarters. During his sojourn in South America he plans to visit every oil field in the South American republics and also the island of Trinidad.

Southern Alkali Corporation Opens Plant

The Southern Alkali Corporation recently opened its new plant at Corpus Christi, Texas, a project that has been under way for three years. Caustic soda, soda ash and other common alkalies used by petroleum refiners and various other industries will be manufactured.

The plant site is adequately served by both rail and water transportation facilities, and all requirements for the manufacture of alkalies are within ready access, including salt, limestone, coke, oyster shells and necessary power. The salt is supplied by gravity flow from company wells 60 miles distant and stored in an open reservoir. Coke and limestone are shipped to the plant from near-by southern points. Oyster shells, a valuable source of lime, are obtainable in abundance from the large deposits in Nueces Bay.

The Southern Alkali Corporation is a joint subsidiary of the Pittsburgh Plate Glass Company and the American Cyanamid Company.

U. S. Rubber Appoints New Packing Sales Manager

The United States Rubber Company announces the appointment of Ralph C. Harden as manager of packing sales in the mechanical goods division. He will be located at the company's main offices at 1790 Broadway, New York City.

During the last 15 years he held several important positions with the Johns-Manville Sales Corporation, the latest of which was western regional vice-president of sales with headquarters in Chicago.

C. A. BARRERE, formerly assistant superintendent and plant engineer of the Texas Pacific Coal and Oil Company's refinery at Fort Worth, Texas, is now assistant manufacturing superintendent of the Phillips Petroleum Company's refinery at Okmulgee, Oklahoma.

T. E. (TOMMY) WARD, export representative for several American manufacturers of oil equipment, has returned to New York with his family after an extended visit in England, Holland, Belgium and France. Ward said, upon his return, that in every country he visited he noticed a better feeling toward the United States. "Even though finance may be in difficulty," he stated, "friendship is far from being in bankruptcy."

M. J. FLANAGAN, of the Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, spent his vacation at his old home in Bradford, Pennsylvania, and while in that part of the country took in the Diamond Jubilee at Titusville.

FRANK HINDERLITER, president of the Hinderliter Tool Company, and Fred E. Cooper, president of the Fred E. Cooper Company, both of Tulsa, Oklahoma, attended the Diamond Jubilee of Oil at Titusville, Pennsylvania.

CHARLES BUNJE, JR., president of the Illinois Pipe Line Company, Findlay, Ohio, has returned to headquarters after spending two weeks in Wyoming making a survey of company properties.

SNETCHER AND PITTMAN, INC., of Oklahoma City, Oklahoma, recently opened a branch store and bit shop at Scott, Louisiana, to serve Louisiana gulf coast customers. Gus Layton is in charge. The store is carrying a stock of Green Head three-way drag bits and a line of oilfield specialties, including O. K. pump pistons, Raybestos brake lining and U. S. Rubber hose. Bits will be serviced in the shop run in connection with the store.

W. D. OWSLEY, for the last two years district engineer in the Gulf Coast area for the Halliburton Oil Well Cementing Company, with headquarters at Houston, Texas, has been transferred to the Los Angeles, California, territory, where he will be district engineer.

E. A. SATCHELL, London, England, production manager of the Iraq Petroleum Company, is now in the United States, having arrived recently on the S. S. Berengaria.

J. M. (SKEETS) O'MELVENY is now field representative in Kansas and Oklahoma for the Patterson-Ballagh Corporation, Los Angeles, California. His address is 1023 NW 32nd Street, Oklahoma City, Oklahoma.

CARL MEYER, sales manager of the Continental Supply Company, Dallas, Texas, recently returned from a vacation, most of which was spent in St. Louis, his former place of residence.

HAROLD G. SEER has been made a director of the Simms Petroleum Company, succeeding Charles D. Hartman, Jr., who resigned recently.

A. M. LOCKHART, formerly with the Rio Grande Oil Company, is now vice-president of the Envoy Petroleum Company, Long Beach, California.

EARL E. SMITH, manager in the Tulsa district for the National Tube Company, has been transferred to Pittsburgh, Pa., as assistant superintendent in charge of field work. Frank Braman, field engineer, is now manager at Tulsa.

FRANK O. PRIOR, president of the Stanolind Oil and Gas Company, who recently was appointed a member of the Oklahoma Production Committee, has now been made vice chairman of that body. He succeeds C. C. Herndon, vice-president of the Skelly Oil Company, resigned. The latter retains a membership on the committee, however.

P. F. CERVENY of Palestine, Texas, has been sent to Caldwell, Kansas, as manager of a Gypsy Oil Company seismograph party working out of that point. He replaces E. M. Palmer, who was transferred to a party stationed at Guthrie, Oklahoma.

H. C. HIGGINSON has been appointed manager of the Ulster branch of the Anglo-American Oil Company, succeeding J. Harper Hunter, who resigned because of ill health.

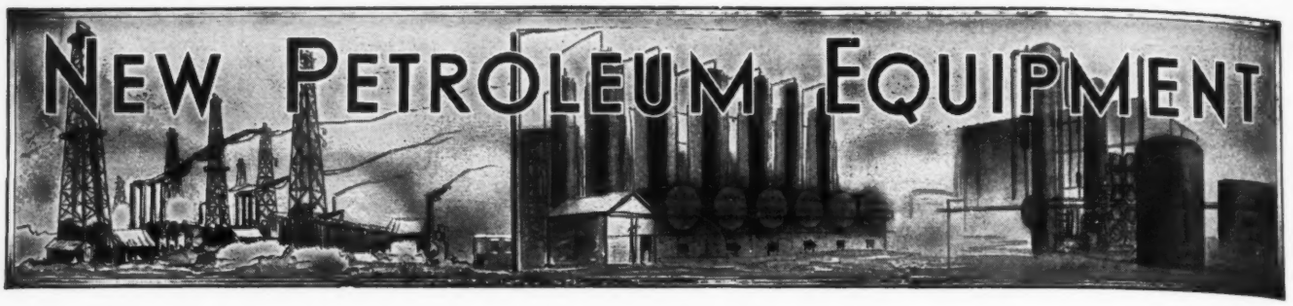
E. H. SALRIN, vice-president of the Tide Water Oil Company, Houston, Texas, has returned to the Mid-Continent from California, where he spent his vacation.

RALPH ANDERSON, a foreman for Simms Oil Company, has been made district superintendent in charge of the Tonkawa, Oklahoma, district, succeeding the late Fred L. Riley, who died recently. Anderson has been with the Simms organization since 1926.

SIR HENRI W. A. DETERDING, managing director of the Royal Dutch Shell interests, has returned to Europe, having spent ten days in the United States on business.

E. M. LYONS recently resigned as president of the Tiona Refining Company of Philadelphia, Pa., a position he had held since 1926. He has announced no plans for the immediate future.

THE SKELLY OIL COMPANY has announced the promotion of a number of its field men. J. H. McCullough, district clerk at Eldorado, Kansas, was promoted to district foreman for Butler and Greenwood counties. His office will remain at Eldorado. D. W. Silivis, clerk at Bristow, Oklahoma, has been made district clerk at Eldorado to succeed McCullough. H. V. Morris has been placed in charge of Skelly's district that comprises Reno, Harvey, eastern Rice and McPherson counties in Kansas. Floyd Kent is the new district foreman in western Rice, Russell, Kingman and Pratt counties.



Thread Protector That Will Not Come Off

A SIMPLE and practical thread protector recently was placed on the market by the Pipe Protector Company, 230 Oliver Building, Pittsburgh, Pennsylvania. This consists of a narrow band of lap-welded strip steel and a formed coating of vulcanized rubber.

The protectors were patented some time ago, and several leading pipe companies are now conducting exhaustive tests with them.

The sponsors are awaiting their verdict, and meanwhile plans are going forward swiftly for construction of a factory, and orders are already being booked in large quantities.

Additional information will be furnished by the manufacturers upon request.

G-E Electrode Produces Class I Welds in Any Position

A GENERAL-PURPOSE welding electrode, designed as the Type W-22, has been added to the General Electric line of arc welding electrodes. The new electrode is of the heavily coated or shielded-arc type and produces welds of the quality required for Class I pressure vessels according to the A.S.M.E Boiler Construction Code. Its distinctive feature is that it may be used in any position, i.e., for flat, vertical, or overhead welding, and at the same time has deep penetrating properties. It is, therefore, equally suitable for butt and fillet welds.

Tests on all-weld-metal specimens made from Type W-22 electrode show the following average results, which more than meet the rigid Class 1 requirements:

Tensile strength: 65,000 to 75,000 lb. per sq. inch.

Elongation: 20 to 30 per cent in two inches.

Impact resistance: 30 to 45 ft. lb. (Charpy).

In addition, welded joints average 35 to 60 per cent elongation when tested by the free bend method and X-ray, Class I.

Because these physical properties are obtained without regard to the position in which the welds are made, there is no necessity for moving the work so that welding may be done in a down-hand position. Heretofore, position welds of Class I quality were not generally obtainable.

The W-22 electrode has a wide field of application in the fabrication of large structures where it is impossible or impracticable to move the work into a special welding position, and in the welding of such fittings as nozzles and flanges to pressure vessels where handling costs are less if positioning of the work is unnecessary.

EC & M Type ZO Motor Starter

FOR motors up to 15 hp., 220 volt, and 30 hp., 440-550 volts, the Electric Controller and Manufacturing Company, East 79th Street and Woodland Avenue, Cleveland, Ohio, announces the EC & M Type ZO weather-proof and dust-tight, across-the-line, oil-immersed motor starter. These starters are enclosed in a case that has been bonderized and black enameled. When desired, a self-contained ammeter in a dust-tight case also can be furnished. The starter is arranged for remote control, push-button automatic operation.

Slip Suspension Bradenhead

OIL CENTER TOOL COMPANY, Houston, Texas, announces production on the O-C-T Type "J" slip suspension bradenhead following satisfactory tests in the field.

Type "J" is made of forged steel throughout, except the slip bowl,

which is cast chrome nickel steel. The packing is of hydraulic or asbestos, subject to the user's requirements. The head is tested to 5000 pounds.

The upper end of the main body has the same size A.P.I. casing thread as the bottom, making it possible to screw the bradenhead onto the casing and screw a blowout preventer on top of the bradenhead before running and cementing 7-in. pipe, leaving the blowout preventer closed around the 7-in. pipe while the cement is drying.

The bradenhead illustrated here is 10¾-in. O.D. to 7-in. O.D., with two 3-in. gas outlets.

Landis Pipe and Bolt Threading Machine

A NEW combination pipe and bolt threading machine, called the Little Landis pipe threading and cutting machine, is being announced by the Landis Machine Company, Waynesboro, Pennsylvania.

This new machine is the only one of its type that employs the distinctive Landis die-head and the Landis Long Life patented chaser. It is of the lathe type in which the work is revolved, and is designed to thread, ream, and cut off pipe and thread bolts, rods, etc. The features of the machine

pointed out by the manufacturer include light weight, quick set-up changes, economical operation, and moderate price.

The machine is made in the motor-driven type only, employing a 1-hp. motor and control of the industrial type. The motor is mounted in an enclosed compartment in the bed and is connected to the geared headstock by means of a silent chain drive.

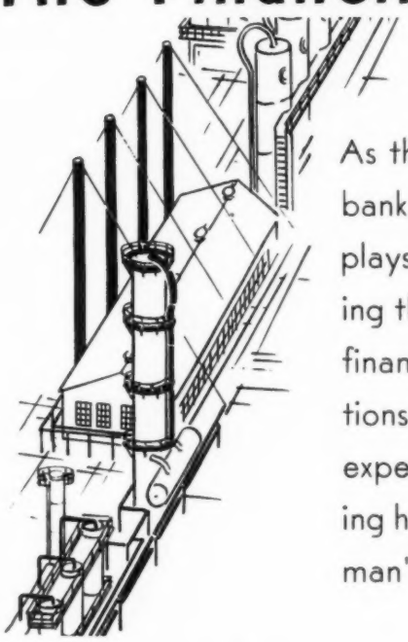
A one-piece box-type bed is employed. The gear box through which three changes of speed are available, is cast integral with the spindle housing, thus affording unusual rigidity. All gears are cut from steel and run in an oil bath.

The cross rail, which supports the die head and cutting-off and reaming tools, is integral with the carriage. The unit is of a sturdy design and is centrally located on the carriage so as to eliminate an overhang. A scroll chuck of the three-jaw universal type is employed.

The Landis die heads are of an entirely new design, combining light weight and maximum rigidity and strength. The heads are of the quick-opening type and have a universal adjustment for size. Two die heads, having a combined capacity ¼ in. to 2 in., are furnished as standard equipment. By applying bolt chaser holders, the 2-in. head can be used for threading bolts from ⅜ in. to 1¼ inch. The die heads are adjusted for diameter through a self-locking ratchet screw. The adjustment is universal and is quickly made. The setting of the chasers in the chaser holders remains constant for all diameters. The chasers used in the die head are of the Landis tangential type and are of the same design as those employed in the standard line of Landis die heads and machines.

The die heads are supported on two pins extending from the front face of the cross rail. Due to their light weight, the heads can be readily handled, thus facilitating set-up changes when it is necessary to interchange the die heads.

The Financing of Oil



As the Southwest's largest bank, the First National plays a vital part in mobilizing the credit necessary to finance sound oil operations in the Southwest. Its experience in such financing has qualified it as an oil man's bank.

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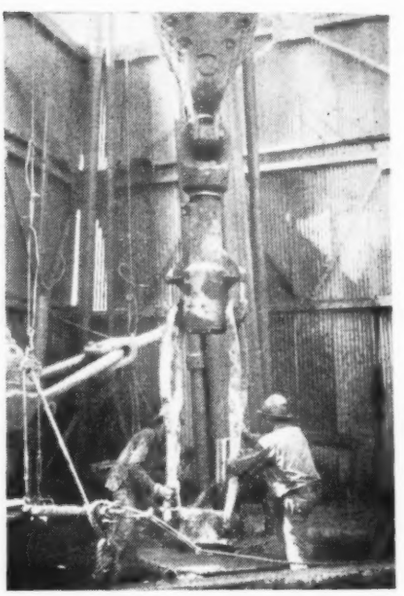
Web Wilson Develops Oil Well Tool

WEB WILSON, who for years was general manager of Wilson & Willard Manufacturing Company, which later was purchased by another tool concern, has developed an oil well tool that he believes will meet with the same success as the original Wilson & Willard tools. He has developed what will be known as the Web Wilson connector. It will be marketed under his personal supervision. This connector embodies strength beyond that of any other hook or hook substitute, states Mr. Wilson. It is calculated to withstand 923,000 lb. dead load with safety factor of two and one-half. Total weight of the connector is 2240 pounds. The spring has a 10-in. travel in comparison with the usual 6-inch. This gives flexibility and ease of tension control.

The shock absorbing feature eliminates the bounce of the stand when picked up by the elevator, thus reducing the hazard of an elevator opening and dropping the load. The shock-absorbing action also allows picking the pin out of the box without a bouncing action, which heretofore has been an endless cause of battered threads, says Mr. Wilson. The center of gravity is in the exact center of the tool. The Web Wilson connector can be changed from drilling to setting casing within a few minutes.

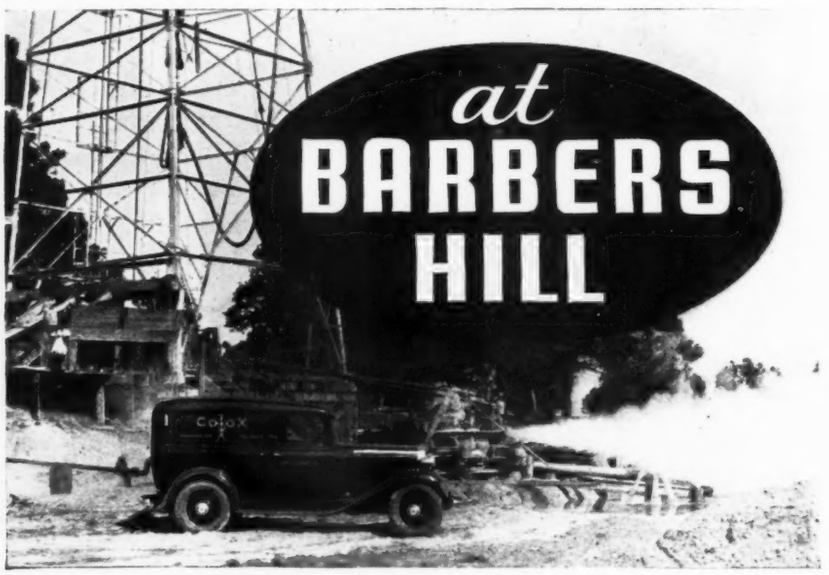
A novel bearing permits sufficient initial set to be put in the spring without preventing free swiveling. All the 10 inches of spring movement are usable for handling loads of various sizes of drilling pipe.

The connector is made of special steel castings and forgings of alloy steel. The ears support the elevator links far enough apart that the connector will act as an equalizer. This insures an equal load on each link and elevator ear, regardless of the unequal



lengths of the links, Mr. Wilson points out. The load is carried on two ears instead of one point as in a hook.

Mr. Wilson reports that the crews already using this new connector are very enthusiastic concerning it. The connector has been in service on several of the deepest wells and has met with widespread approval, he says. Literature may be obtained by addressing Web Wilson, 418 W. W. Wilson Building, Huntington Park, California.



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LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Boss: What made you oversleep this morning?
He: There are eight of us in the house, but the alarm was set only for seven.

* * *

When you see a dog leading a man, you know that that man is blind; but when you see a man leading a dog, you know that that man is leading a dog's life.

* * *

First Negro: Gosh! Sam's done wiggled his feet twice today. What's de matter wid 'im?
Second Ditto: Well, he's one of dese niggers dat don't believe in layin' around all day doin' nothing.
—*Annapolis Log.*

* * *

A Jersey cow swallowed a ten dollar gold piece several years ago. Recently the coin was found in her stomach after she was butchered. Her owner often wondered what made her milk so rich.

* * *

Sign in Los Angeles dance hall: "Good Clean Dancing Every Night but Sunday."

* * *

A lot of fellows who complain about their boss being dumb would be out of jobs if the boss were any smarter.

* * *

A newly created papa received the glad tidings in a telegram:
"Hazel gave birth to a little girl this morning; both doing well."
On the message was a sticker reading:
"When you want a boy call Western Union."

* * *

First Lady: Do you always look under the bed?
Second Lady: Always.
First: Ever find anything there?
Second: Only in old-fashioned hotels.

* * *

It takes 1500 nuts to put an automobile together, but only one to scatter it all over the landscape.

* * *

Jones had occasion to reprimand his wife. "I think, dear," he said soothingly, "that you fib a little occasionally."
She immediately became indignant.
"Well, I think it's a wife's duty."
"Wife's duty?"
"Yes, to speak well of her husband occasionally."
—*Bridgeport Bulletin.*

* * *

"Are you familiar with mules?" asked the farmer of the colored employee.
"No, sir; ah knows too much about dem to be familiar wit 'em."

* * *

A negro boy, going through a cemetery, read this inscription on a tombstone: "Not dead, but sleeping."
Scratching his head a while, the boy remarked: "He sure ain't foolin' nobody but hisself."

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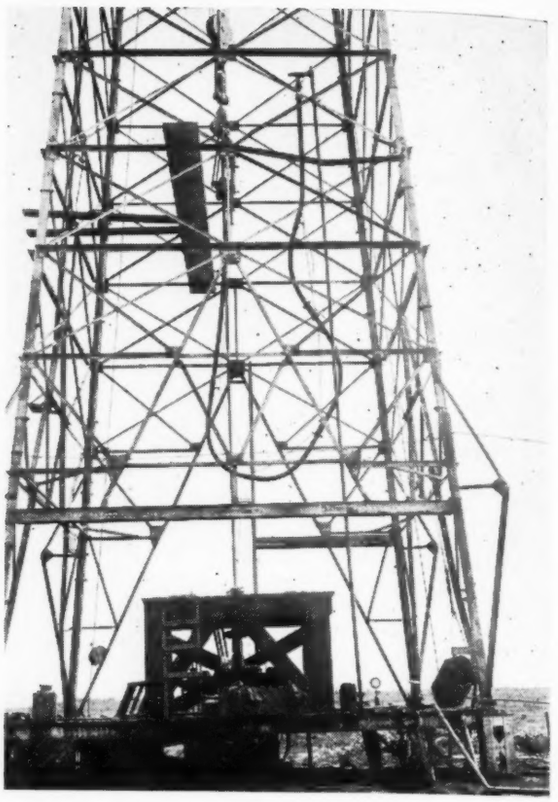

Cleaning-out a well with high-pressure gas. The arrangement of high-pressure hose, tubing swivel, and control equipment allows free movement of tubing while the well is flowing

By

J. S. ROSS[1]

Cleaning-Out Oklahoma City Wells With Gas

WITH bottom-hole pressures now declined to 300-500 lb., Oklahoma City operators are faced with a "cleaning-out" difficulty that apparently will require the use of other than the customary methods and equipment. Obviously, the presence of sand and shale cavings in the bottom of these deep wells will, at present low bottom-hole pressures, seriously interfere with their ability to produce. Obviously, too, the use of rotary methods are out of the question because of the high fluid pressure exerted against the sand. The use of cable tools in attempts to remove large quantities of sand and shale from a depth of 6500 ft. has not been generally considered satisfactory. In addition, there is a considerable hazard because of the large cavities in these wells, such cavities having resulted from the "stop-cocking" operation of the wells, from shooting, and from the unconsolidated nature of the producing horizons. For these reasons also, the use of various forms of "suction" bailers has not been entirely successful.

As a possible means of overcoming these difficulties in a more satisfactory manner, operators recently have been turning to the use of the "Arco Process" as a cleaning-out method. This process, introduced into the Oklahoma City field by the Indian Territory Illuminating Oil Company, was developed originally in the eastern fields by I. L. Dunn and patented by him. It consists essentially of circulating high-pressure gas down through and up around the well tubing. The return flow of the gas, together with the fluid that the well makes, is used to flow out the unconsolidated cavings. Cavings are rapidly flowed from the well, and the danger of losing tools in the cavities is minimized. The entire clean-out operation is carried out without exerting a pressure against the face of the sand in excess of formation pressure, and with the well producing into the separator at its maximum capacity.

More than 70 wells, ranging in production from 20 to 800 bbl. per day, have been successfully cleaned out with gas. The amount of cavings removed varied from 30 to 300 ft., 126 ft. representing probably a fair average. With but a few exceptions, the cleaning-out operations have resulted in substantial gains in production. For example, the average daily rate of production of 16 Wilcox sand wells was increased from 2656 bbl. to 3492 bbl. per well, or an average gain of 836 bbl. per well. Excellent results also were obtained on 17 Simpson sand wells, the average rate of production being increased from 131 to 203 bbl., or a gain of 72 bbl. per well per day.

The equipment required for the successful operation of the process consists essentially of a string of tubing containing two check valves (one at the top and one at the bottom), a high-pressure hose connecting the tubing swivel and the gas supply, and suitable control equipment that permits free movement of the tubing while the well is flowing. In addition to the customary well-pulling equipment for raising and lowering the tubing, there are provided a weight indicator, and a pressure gauge, or preferably an orifice meter, on the input gas line. A portable hoist or tractor is used for power.

Tubing of 2-in. or 2½-in. dia. is used in the Oklahoma

TYPICAL EXAMPLES OF THE RESULT OBTAINED BY CLEANING OUT WITH GAS IN WILCOX WELLS IN THE OKLAHOMA CITY FIELD

Well	No. days on location	No. hours cleaning out	Depth to top of cavings	Depth cleaned out to	No. ft. cleaned out	Production before cleaning out—bbl. per day	Production after cleaning out—bbl. per day	Increased production—bbl. per day
A	18	52	6104	6420	316	265	1100	835
B	6	15	6328	6429	101	5400	8600	3200
C	6	24	6328	6430	102	1800	2400	600
D	3	26	6338	6425	87	4500	7200	2700
E	4	36	6328	6470	142	1800	2300	500
F	4	33	6380	6440	60	960	1390	430
G	4	26	6393	6450	57	2500	2620	120
H	4	31	6429	6460	31	2400	3000	600

[1]The Southern States Company, Dallas, Texas.

City work, and after cleaning-out is completed, the string of tubing is usually left in for flowing the wells by gas-lift. From 150 to 200 ft. of inserted tubing or internal upset flush-joint drill pipe is used on the bottom to eliminate any possibility of collars sticking the pipe in the open hole. The bottom check valve, which is built inside the tubing shoe, prevents heaving sand from plugging the tubing in the event gas circulation is accidentally interrupted; it also prevents the well from flowing through the tubing while the pipe is being pulled. The second check valve, placed near the top of the string, permits adding additional joints without releasing the pressure already in the tubing. The tubing shoe, or bit, usually has a restricted outlet, this restriction acting both to limit the rate of discharge of high-pressure gas out of the tubing while a new joint is being swung up and to make the action of the orifice meter more sensitive.

Flush-joint tubing shoe and check valve

Control equipment, consisting of a tubing blow-out preventer, oil-saver, and tubing spider, is connected above the cross leading to the separator. If the tubing string is to be left in the well, a tubing landing support is placed between the cross and blow-out preventer, permitting removal of the latter without interrupting flow from the well. Scaffolding is erected to provide a platform of ample height for the workmen.

A high-pressure hose, 35 to 50 ft. in length, having an internal diameter of not less than that of the tubing, and a stand pipe of equal length, permit ample vertical movement of the tubing while cleaning out is in actual progress. As the hose conveys gas that is under high pressure and invariably quite hot, there is always the danger of it drying out and parting, usually with disastrous results. A steel cable, securely anchored to firm supports at either end, is therefore run alongside the hose and clamped to it at intervals as a safety measure.

A measuring line is first run to determine the exact depth to the top of the cavings; the tubing is then run to within a few joints of this determined depth. Next, the top check valve is screwed on and one or two more joints of tubing added. As soon as the swivel and hose connections are made, the well is "kicked off" and the tubing slowly lowered or "worked down" to the cavings. These are churned up by the jetting action of the gas and carried to the surface with the flow of oil and gas. The amount of weight applied on the shoe of the tubing is indicated not only on the weight indicator attached to the dead line, but also by the pressure gauge or orifice meter on the input-gas line. Setting the shoe down firmly on sand cavings tends to restrict the flow, which is indicated at the surface by a rising tubing pressure or by a falling differential on the orifice meter. By closely observing these instruments the amount of weight applied to the bottom of the tubing can be closely regulated.

Since the well cuttings are unconsolidated, and their dislodging and removal dependent upon the agitation caused by gas discharge across the face of the bit and also the rate of flow between the casing and tubing, nothing is gained by "crowding" the tubing. In fact, extreme care must always be taken to prevent any appreciable weight from being put on bottom, for, because of the cavities present, such action would tend to corkscrew the tubing and might even break it off near bottom. The danger of this latter, however, is obviously much less than the danger of losing bits or bailers in these cavities.

The quantity of gas and the amount of pressure required depends upon the amount of fluid lifted, the size of the casing, and the quantity of free formation gas that is available. Volumes, based on daily rate, range from 2½ to 5 million cu. ft., and pressure from 400 to 650 pounds. An input gas pressure of around 600 lb. is preferable because solid matter is more effectively and more rapidly removed in a well flowing steadily than in one that is "heading." Some operators prefer trapping the sand in the separator and removing it at that point by frequently draining the bottom, while others permit the sand to be carried to the flow tanks. Invariably, considerable sand is carried to the stock tanks, regardless of how much is removed at the separator. An example of the large quantities of sand handled is that of one well from which 175 bbl. of sand were removed in two days.

Although the overall time on a location varies from three to ten days, including rigging up and moving off, the actual cleaning-out operation is relatively very short. Figures based on the average of 16 Wilcox wells in the north end of the field recently cleaned out, show that 126 ft. of cavings were removed in 33.8 hours, or at the rate of 3.7 ft. per hour. Even more rapid cleaning out is recorded in the case of a group of 17 small Simpson sand wells, from which cavings were removed at the average rate of 5.6 ft. per hour.

It has been possible in some instances to clean out wells in which one or more bailers and other drilling equipment have been lost. For example, the well indicated by (H) in the accompanying table has three bailers in the hole. In another well tubing was run past considerable line and a bailer, and cleaned out to bottom with favorable results.

While the technique of cleaning Oklahoma City wells under this process is still undergoing changes and improvements, it has developed now to the point where it has been definitely demonstrated that this new method permits more rapid, thorough and cheaper operation than older methods, at the same time minimizing the hazards that always accompany operations at these depths.

Mud pit, five ft. deep, filled with sand cavings removed from a Wilcox sand well in the Oklahoma City field

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A. P. I. Production Committees Appointed

Announcement has been made from the Division of Production headquarters of the American Petroleum Institute at Dallas, Texas, of the appointment of the following committees for 1934:

Topical Committee on Development and Production Research (of the Central Committee on Drilling and Production Practice):

National chairman, G. V. D. Marx, Standard Oil Company of California, San Francisco, Calif.

California District: C. J. Coberly, chairman, Kobe, Inc., Los Angeles, Calif.; R. E. Allen, Oil Umpire's Office; F. E. Davie, Shell Oil Company; Donald E. Dickey, Broderick & Bascom Rope Company; and John F. Dodge, University of Southern California, all of Los Angeles; Stanley C. Herold, 1330 Ethel Street, Glendale, Calif.; William N. Lacey, California Instiute of Technology, Pasadena, Calif.; F. G. Tickell, Stanford University, Palo Alto, Calif.; and Lester C. Uren, University of California, Berkeley, Calif.

Eastern District: R. D. Wyckoff, chairman, Gulf Research & Development Corporation, Pittsburgh, Pa.; George H. Fancher, Pennsylvania State College, State College, Pa.; Charles R. Fettke, Carnegie Institute of Technology, Pittsburgh, Pa.; H. C. Fowler, U. S. Bureau of Mines, Washington, D. C.; J. Lewis, Pennsylvania State College, State College, Pa.; H. J. Lowe, Pure Oil Company, Newark, Ohio; and H. B. Soyster, U. S. Geological Survey, Washington, D. C.

Mid-Continent District: H. H. Power, chairman, Gypsy Oil Company; L. G. E. Bignell, Oil and Gas Journal; F. W. Floyd, Carter Oil Company; C. V. Millikan, Amerada Petroleum Corporation; and J. J. Zorichak, Stanolind Oil & Gas Company, all of Tulsa, Okla.

Southwestern District: F. E. Heath, chairman, Sun Oil Company, Dallas, Texas; M. G. Cheney, Anzac Oil Company, Coleman, Texas; R. H. Fash, Fort Worth Laboratories, Fort Worth, Texas; Stanley Gill, Rusk Building, Houston, Texas; T. V. Moore, Humble Oil & Refining Company, Houston, Texas; F. B. Plummer, University of Texas, Austin, Texas; R. B. Whitehead, Atlantic Oil Próducing Company, Dallas, Texas; and H. D. Wilde, Jr., Humble Oil & Refining Company, Houston, Texas.

Rocky Mountain District: F. E. E. Germann, chairman, University of Colorado, Boulder, Colo.; Clark F. Barb, Colorado School of Mines, and B. B. oBatright, Colorado School of Mines, both of Golden, Colo.

Foreign: Joseph A. Holmes, Jr., Lago Petroleum Company, Maracaibo, Venezuela.

Central Committee on District Activities: W. H. Weier, The Atlantic Oil Producing Company, Dallas, Texas, chairman; W. J. Crites, Phillips Petroleum Company, Bartlesville, Okla., vice chairman; C. A. Young, American Petroleum Institute, Dallas, Texas, secretary; Bruce Barkis, Rio Grande Oil Company, Los Angeles, Calif., California District section chairman; J. H. Newlon, Philadelphia Company, Pittsburgh, Pa., Eastern District section chairman; C. O. Rison, Indian Territory Illuminating Oil Company, Oklahoma City, Okla., Mid-Continent District section chairman; W. T. Doherty, Humble Oil & Refining Company, Houston, Texas, Southwestern District section chairman; John R. Suman, Humble Oil & Refining Company, Houston, Texas, representing Central Committee on Standardization of Oil Field Equipment; and W. R. Trelford, Humble Oil & Refining Company, Houston, Texas, representing Central Committee on Standardized Procedure for Measuring, Sampling and Testing Crude Oil.

C. R. Weidner, Sinclair Prairie Pipe Line Company, Independence, Kans., representing Central Committee on Pipe Line Transportation; M. E. Brock, Gulf Production Company, Houston, Texas, representing Committee on Disposal of Production Wastes; R. E. Donovan, Standard Oil Com-

pany of California, San Francisco, Calif., representing Committee on Accident Prevention; George F. Prussing, Union Oil Company of California, Los Angeles, Calif., representing Committee on Fire Prevention; W. K. Whiteford, Barnsdall Oil Company, Tulsa, Okla., representing Central Committee on Drilling and Production Practice; and George P. Bunn, Phillips Petroleum Company, Bartlesville, Okla., representing Main Committee on Measuring, Sampling, and Testing Natural Gas and Natural Gasoline.

G. W. Walton Promoted by Emsco

E. M. Smith, president and general manager, has recently announced the appointment of George W. (Jack) Walton as manager of the machinery division in the Mid-Continent of the Emsco Derrick and Equipment Company.

(Monnigs Photo Reflex)
GEORGE W. (JACK) WALTON

Walton attended the Missouri School of Mines and has been active in the supply business for past 14 years, having been connected in the Mid-Continent with The National Supply Company and with Wilson-Snyder. He also was located in the London, England, office of the National Supply Company at one time and for the past eight years has been connected with the Mid-Continent sales department of Emsco Derrick and Equipment Company. Mr. Walton will have his headquarters in the Continental Building, Dallas, Texas.

Tom Reagan Joins Appleman Bit Organization

Tom Reagan has joined Authorized Appleman Bit Service Company, of Houston, Texas, as sales and service representative in South Louisiana, and will be headquartered at Lake Charles. His appointment is in line with wider distribution of the Hunt retractable core barrel and the company's rental service on Appleman bits.

Reagan's experience includes four years with Clark & Cowen, drilling contractors, and six years in the sale of oil tools.

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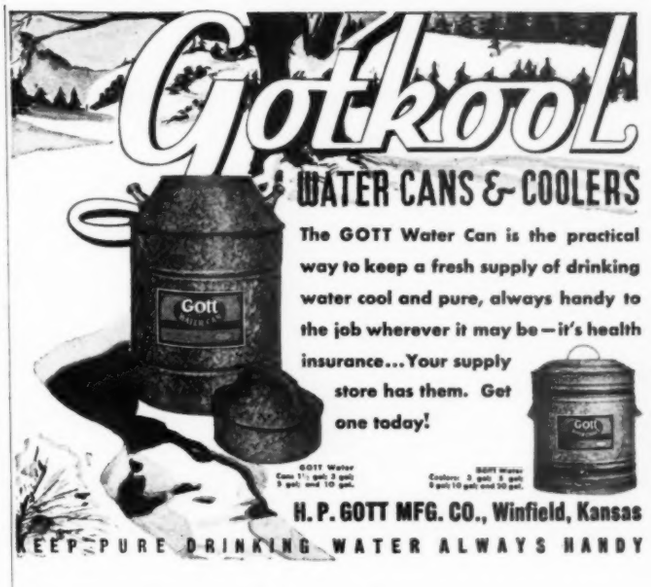
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TRETOLITE COMPANY

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COUPLING THREADS—*cut by a powerful, yet marvelously precise, machine*

Oil country couplings carry a great responsibility, for the strength of a string of casing or tubing lies in the connections. The boring and tapping machines used by Jones & Laughlin perform the really remarkable job of producing couplings of correct dimensions and proper alignment, of cutting clean threads with precisely accurate pitch and taper. Such couplings run smoothly and rapidly. To them belongs a large share of the success earned by **J&L** Seamless Drill Pipe, Casing and Tubing. Send for a free copy of the **J&L** Pipe Handbook containing, in addition to data, many interesting photographs of manufacturing operations.

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AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

J&L STEEL

J&L PIPE

J&L SEAMLESS

DRILL PIPE · CASING · TUBING · LINE PIPE

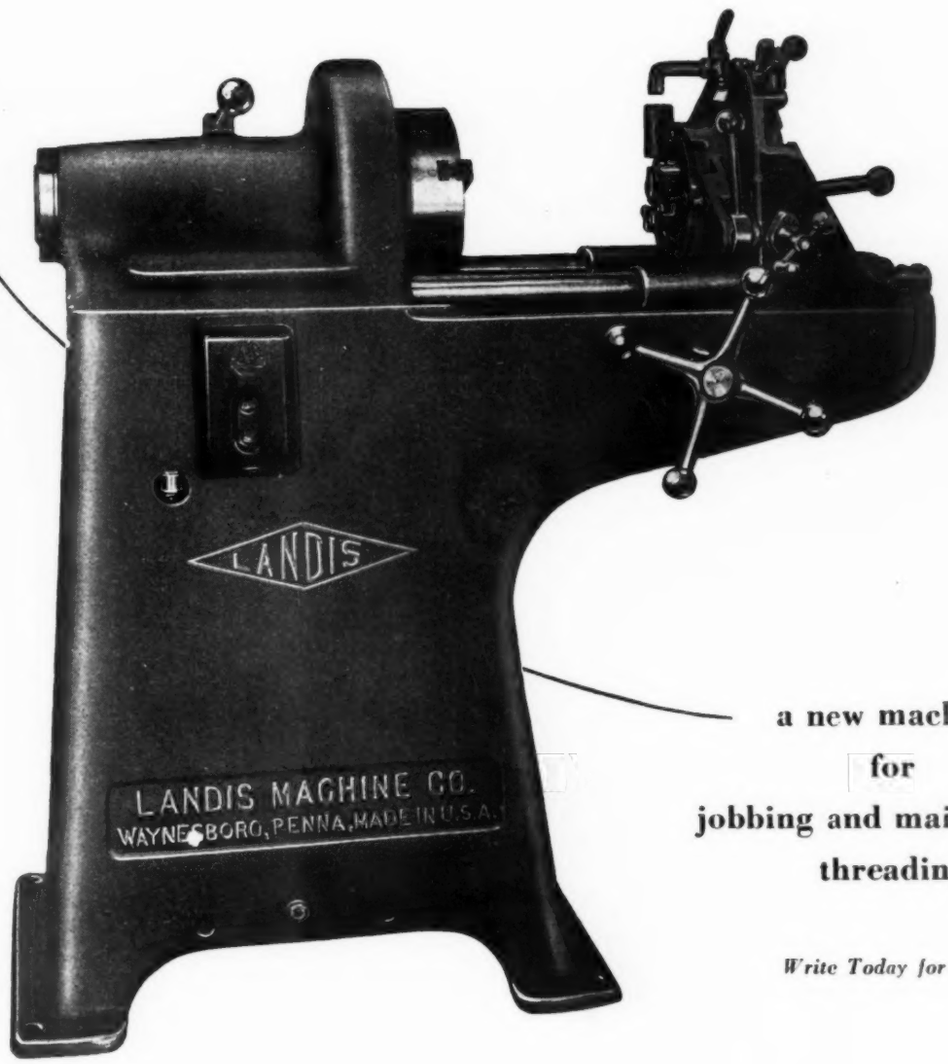
Introducing

The "LITTLE LANDIS"

THE "LITTLE LANDIS" Pipe Threading and Cutting Machine is designed to thread, ream, and cut-off pipe, and thread bolts, rods, etc. in jobbing and maintenance shops.

The primary purpose of the machine is to provide means for handling work at a minimum cost, to permit of the quickest possible set-up changes, and to produce cleanly cut, accurate, well-formed threads on all materials.

In building the "LITTLE LANDIS," the ever-present thought has been to offer a machine thoroughly tried and proven—a machine of unquestioned ability, and of unquestioned quality.



a new machine
for
jobbing and maintenance
threading

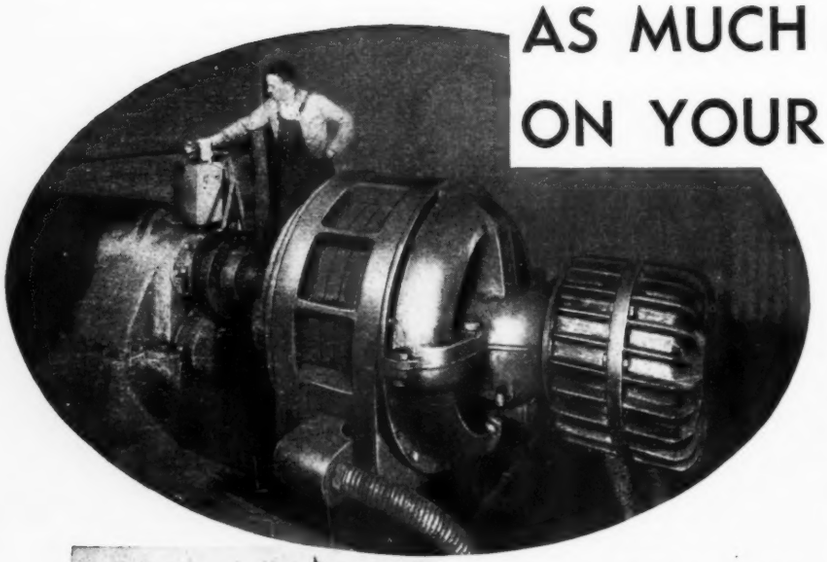
Write Today for Details

LANDIS MACHINE COMPANY

Waynesboro, Penna.

The Petroleum Engineer, issued thirteen times a year by the Petroleum Engineer Publishing Co., 405-409 Tower Petroleum Bldg., Dallas, Texas. Subscription price, $1.00 per year, except in Canada, where the price is $1.65 per year—15 cents a copy. Entered as second-class mail matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

HOW TO REDUCE POWER COSTS AS MUCH AS 80% ON YOUR ROTARY RIGS



YOU can cut your power costs for drilling by using G-E induction-motor drive. Drilling companies that have changed to this equipment report savings in some cases of as much as 80 per cent in power costs alone with average daily power costs cut to approximately $20. That's real economy!

In addition to this actual power-cost reduction, G-E electric drive offers many other features that will cut your drilling costs, including:

1. **DEPENDABILITY** that reduces shutdowns and costly repairs
2. **PORTABILITY** that cuts moving costs, because there is less material to transport
3. **FLEXIBILITY**—power is immediately available; motors are started and stopped by the throw of a switch
4. **HIGH SALVAGE VALUE,** because of longer life and less-frequent replacements

G-E magnetic control for draw works allows the driller complete speed control and automatically operates to permit maximum starting torque and fast acceleration. Adjustable, definite-time accelerating relays minimize line disturbance and motor heating.

Write or call the nearest G-E sales office to-day. A G-E oil-well specialist will show you, without obligation to you, definite proof of the savings which you can make. General Electric, Schenectady, New York.

OVAL — *G-E 200/65-hp. wound-rotor induction motor driving the draw works on a Santa Barbara, Calif., ocean pier for the Pacific Western Oil Co.*

ABOVE — *This G-E magnetic control for the drilling motor shown above is located in a portable metal house about 100 feet from the derrick*

G-E 75-hp. motor driving a mud pump at the Santa Barbara well, showing steel-skid mounting for easy transportation

020-82

GENERAL ELECTRIC

DEFEND your metal surfaces against the insidious enemy, rust, with the paint that is being accepted more and more as the most efficient rust inhibitive paint for all metal surfaces EAGLE *Sublimed* BLUE LEAD

BASIC SULPHATE OF LEAD, BLUE

Why you can rely on EAGLE *Sublimed* BLUE LEAD

1. Being pure lead, it is most enduring—gripping metal surfaces tenaciously.

2. Being of extremely fine particles, it stays in suspension, doesn't harden in the container or clog the spraying nozzle. Equally satisfactory for brushing, spraying or dipping.

3. Chemically stops corrosion, because of great basicity.

4. Brushes easily, flowing out like enamel. Painters like it.

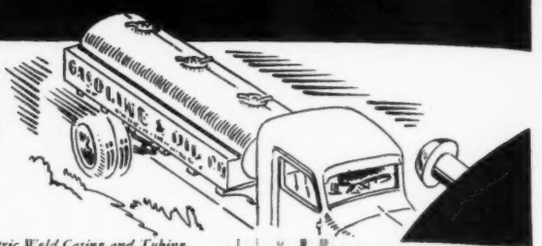
5. Offers greatest economy. First, because lower in first cost than red lead or other high grade metal paints. Second, because of its greater coverage—600-800 square feet per gallon—offers economy of 40-50% in material cost. Third, because it is so long lasting.

THE EAGLE-PICHER LEAD COMPANY

CINCINNATI, OHIO

You can buy Sublimed Blue Lead in paste form (pure lead ground in pure linseed oil) under the Eagle label—or in ready mixed form from reputable manufacturers. Send for descriptive booklet and a free sample

[redacted]



Republic plates and sheets and Upson rivets, nuts and bolts build long life and low upkeep into tank trucks.

Republic Electric Weld Casing and Tubing, grades C and D, are establishing new records where deeper wells demand the utmost in joint strength and in resistance to collapse.

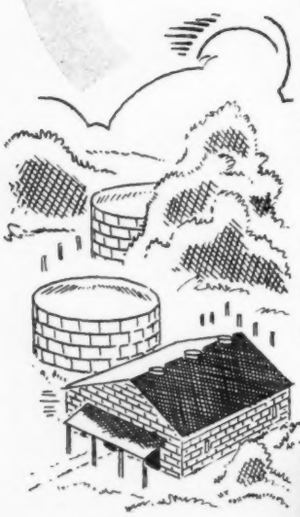
Modern service stations like this of the Standard Oil Company of Ohio are using Toncan Enameling Iron Sheets with Enduro, Republic's perfected stainless steel, as decorative trim. Enduro will not rust, is easy to clean and outlasts the structure.

[redacted]

ILLIONS of dollars are spent annually by the producing, refining and transporting divisions of the petroleum industry for new equipment. Any failure of material is so costly that guesswork simply must be eliminated.

Sensing the changing demands of the industry, Republic long ago planned to keep a step ahead—to be a leader in the movement to substitute positive performance for the hazard of chance. Since then, from Republic's laboratories have come new wear-resisting Agathon alloys to speed up drilling—new corrosion-and-heat resisting alloys, Toncan Iron and Enduro Stainless Steels to challenge salt-and-sulphur laden crudes, and to bring safety to high-temperature operations—and a new method of making better casing, tubing and line pipe by Republic's now famous electric resistance welding process.

Republic has never been afraid to pioneer—to spend time and money in the development of better steels to meet the specific needs of this mammoth industry that can't afford to guess, yet must see that every dollar spent buys value plus.



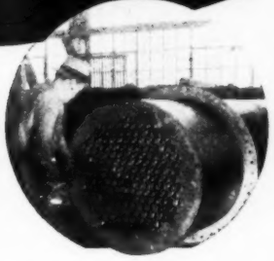
Republic offers a complete line of plain and corrugated sheets for roofing and siding of field buildings, in Toncan Copper Molybdenum Iron, copper bearing steel and plain steel.

[redacted]

ALLOY AND CARBON STEELS • TONCAN IRON • STAINLESS STEEL • PIPE AND TUBULAR PRODUCTS • BARS AND SHAPES • HOT AND COLD ROLLED STRIP PLATES • BLACK, BLUE ANNEALED, GALVANIZED SHEETS • SPECIAL FINISH SHEETS • TIN PLATE • NUTS, BOLTS, RIVETS, ETC. • WIRE PRODUCTS • DIE ROLLED PRODUCTS

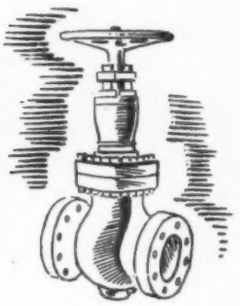
This strainer will outlast many of less modern design. ENDURO, Republic's Perfected Stainless Steel, is the reason.

Thousands of miles of Republic Electric Weld Line Pipe have been laid for gas and oil lines in the last five years. This has been furnished in a wide range of diameters and wall thicknesses to meet economic needs of the industry.

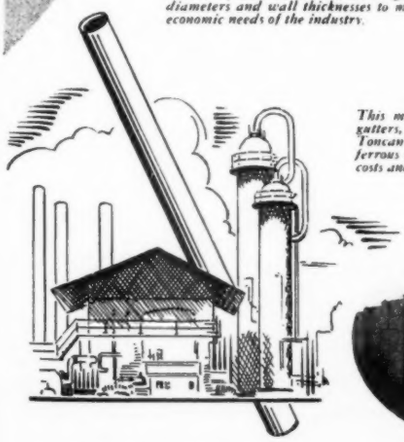


For heat transfer equipment, Electrunite Condenser Tubes, electric resistance welded, are ideal. Easy to roll in—uniform in every detail.

As the oil industry developed, power generation became of vital concern. Costs had to be reduced and better design effected. Temperatures and pressures were increased. New materials and better fabrication were required . . . Republic Electric Weld steel pipe, because of its uniformity of base metal, wall thickness and concentricity, entered the picture . . . Where rust and corrosion were encountered Republic solved the problem with Toncan Iron Pipe.

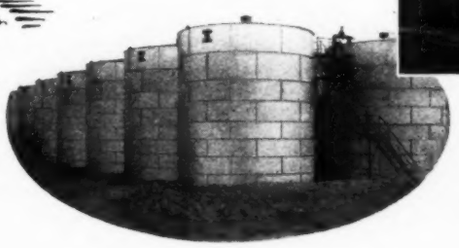


Republic's corrosion-and-heat-resisting steels are now being used by many manufacturers of valves for refinery and pipe line service.



Still tubes of Republic's 4-6 Chromium alloy are setting new records for longer life, efficiency and safety.

This modern Firestone Station used Toncan Iron for gutters, downspouts and decorative metal work—because Toncan Copper Molybdenum Iron outlasts all other ferrous materials in its price class,—lowers maintenance costs and increases life.



Republic plates and Upson Tank Bolts always produce a workmanlike tank,—tight—safe—long lasting. Upson Bolts are available in all grades of steel, also in Toncan Iron and ENDURO stainless steel.

Toncan Iron Pipe is solving many acid sludge line corrosion problems. Electric Weld Toncan Iron Pipe is absolutely free of all scale, inside and outside. It is made in single or double lengths up to 50 feet, no mid weld. Ideal for welding, and by using Toncan Iron welding rod a 100% Toncan Iron installation can be secured.

ALLOY AND CARBON STEELS • TONCAN IRON • STAINLESS STEEL • PIPE AND TUBULAR PRODUCTS • BARS AND SHAPES • HOT AND COLD ROLLED STRIP
PLATES • BLACK, BLUE ANNEALED, GALVANIZED SHEETS • SPECIAL FINISH SHEETS • TIN PLATE • NUTS, BOLTS, RIVETS, ETC. • WIRE PRODUCTS • DIE ROLLED PRODUCTS

THE SPIRIT OF ACHIEVEMENT

Thermoid products are engineered with the same spirit of achievement that has harnessed the great force of electricity . . .

All the electric power we need with the mere turning of a switch. So perfect is the vast equipment that makes it possible, seldom do we give it a thought. And so perfectly *keyed to the task* are Thermoid products for the oil industry that perfect functioning for their entire long life may be taken for granted without question.

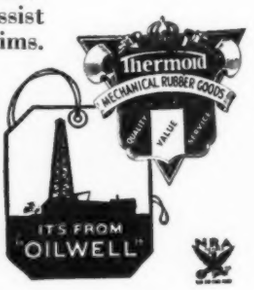
A Thermoid belt, or hose, or brake lining, or packing is a triumph of modern engineering. Like the dynamo, each one is a scientific development. Each one is "engineered" to its particular job, of the exact materials proved by experience to be the best. Each one is skillfully made with a first-hand knowledge of the uses to which it will be put in the industry.

As the entire great oil industry has progressed, so have Thermoid products progressed — and been perfected. Let the name THERMOID assist you in the achievement of your individual aims. *Buy by that quality mark!*

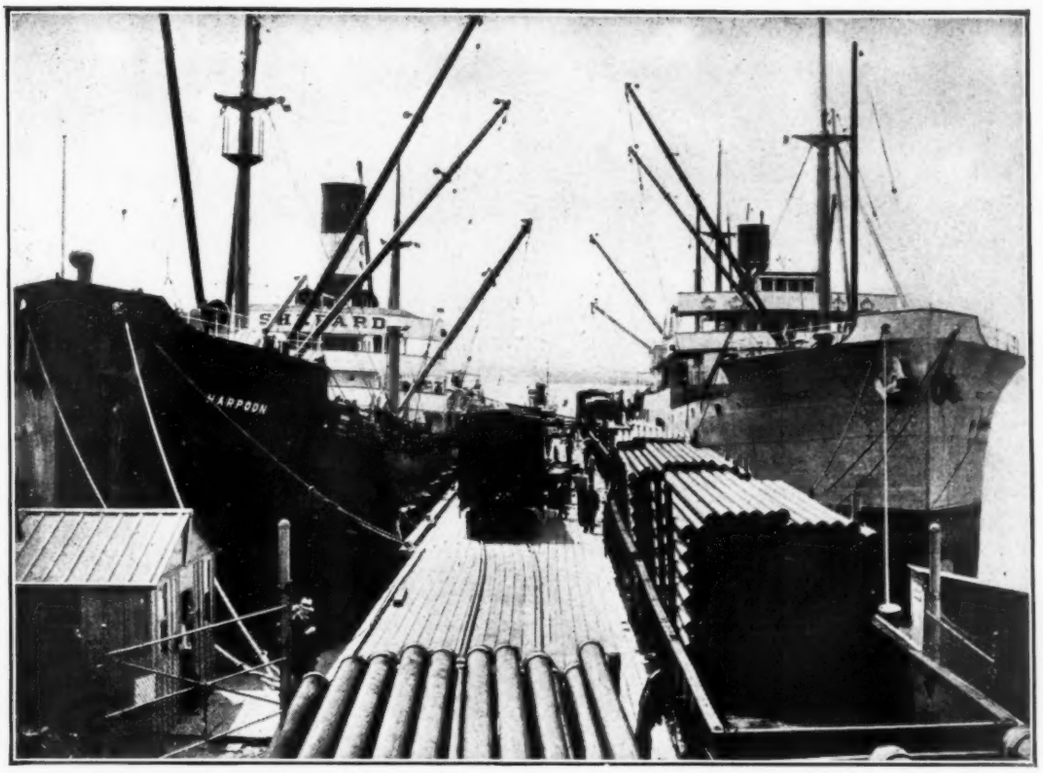
OIL WELL SUPPLY CO.
Branch Stores in all Oil Fields . . . Distributors of

Thermoid

PRODUCTS FOR THE OIL INDUSTRY
Including Oil Pumping and Oil Drilling Belt—Rotary Hose—Air, Steam, Welding and Refinery Hose—Packings and Brake Lining



More Proof of Chester Popularity



One of the many ships being loaded with 100% cargo of "Chester" Casing for the Oil Fields at our pier. If you are looking for a pipe to stand up under severe drilling conditions try "Chester."

Chester also makes "Wrought Iron" pipe—manufactured from genuine old-fashioned hand-puddled muck bar made in our own mills from 100% pig iron.

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J. P. Steele: 603 Petroleum Bldg., Ft. Worth, Texas.

District Offices

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E. L. Moseley: 2218 Mills St., Houston, Texas.
Burt S. Shafer, Southwest Representative: 4313 Fairfax Ave., Dallas, Texas, or 217 Petroleum Bldg., Ft. Worth, Texas.

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United Pipe & Supply Co., Charleston, Danville, West Hamlin, W. Va.; Paintsville, Ashland, Allen, Prestonburg, Ky.

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Kane Supply Company, Kane, Lawrenceville, Brookville, Pa.

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Western Supply Company, Tulsa and Oklahoma City, Okla.; Dallas, Houston, Pampa and Willow Springs, Texas.

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Stephen H. McCabe, 508—4th St., San Francisco, Calif.

Barde Steel Company, Seattle, Wash., and Portland, Ore.

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CHESTER

STEEL CASING AND LINE PIPE

TYPE-80 can TAKE IT

YOU won't have exhaust valve trouble with these Cooper-Bessemer four-cycles. Valves are made of a special heat resisting alloy that does not burn or warp at any temperature reached in gas engine operation. This is proved by engines that have been in service for more than four years with this type of valve. Seats are made of a material similar to that used in resisting the extremely high exhaust temperatures in airplane engines. Cooling water passes directly through these heat-resisting seats. They are designed and built to take it.

THERE'S a lot of satisfaction in operating engines whose "four-cycle economy" is not offset by the expense of frequent shut-downs. These Type-80 compressor units have all the stamina for which the larger Cooper-Bessemer types are so famous. Within the power rating of 85 or 170 B.H.P., no four-cycle unit built today has established its reliability so widely and so well as the modern Type-80. Our nearest representative will be glad to tell you about installation costs, compressor capacities, performance records, and all other details in which you may be interested.

THE COOPER-BESSEMER CORPORATION

Mt. Vernon, Ohio — PLANTS — Grove City, Pennsylvania

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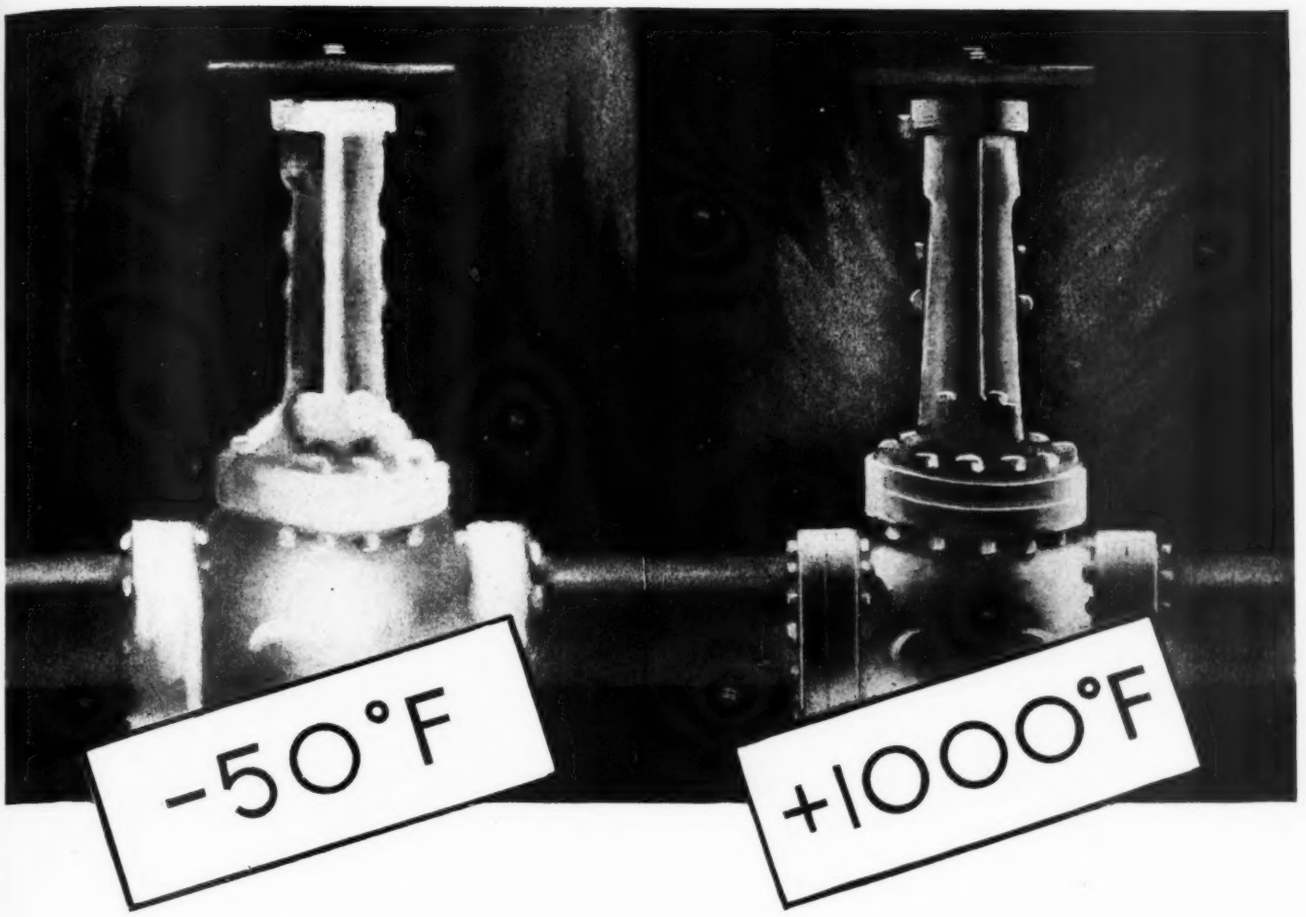


ALL IN THE DAY'S WORK FOR CHAPMAN VALVES

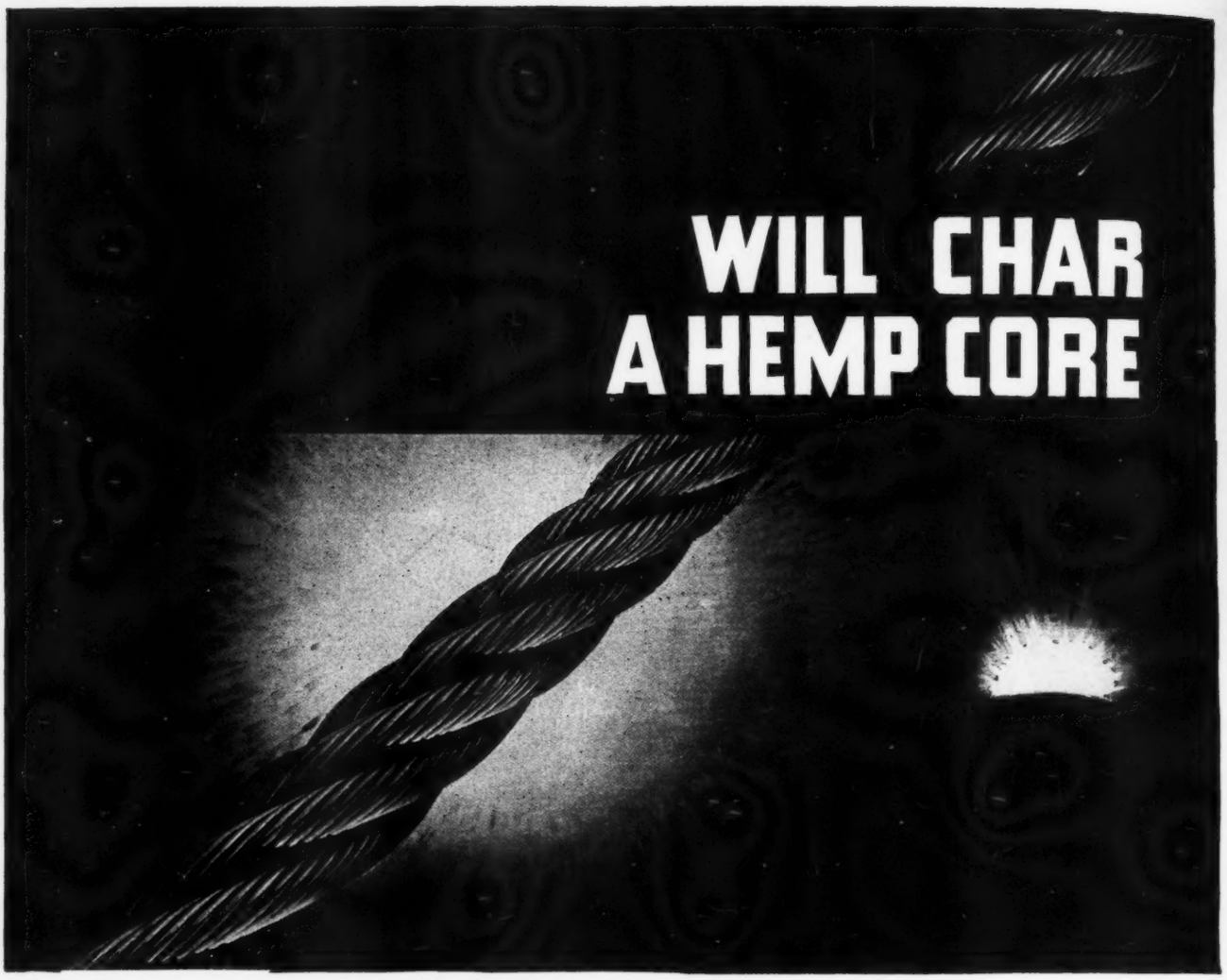
Temperatures of 50° below zero — or 1000° above — hold no terrors for Chapman Valves. Made of metals perfected by Chapman metallurgists for combating the hardest conditions the oil industry has to offer, Chapman Valves take these extremes right in their stride—along with pressures ranging up to 1500 pounds.

When you need fittings or valves for an extra-tough application, turn to Chapman for them. You will find a complete line of gate valves, globe valves, check valves and fittings developed for the Oil Industry and ready to give you years of trouble-free service.

We have an interesting set of charts showing how metals act at temperatures of –50° F. to 1000° F. Write for them.

The CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASSACHUSETTS



Know your Ropes ..This is a helpful hint, how to make wire rope last longer. Subsequent Wickwire Spencer advertisements in this publication will give other dollar saving information. Tell us about your rope problem and we will give you the answer.

When Wire Rope must operate in close proximity to intense heat it is imperative that the rope have an independent wire rope core. The usual hemp core would quickly char in this service and allow the strands to collapse from lack of support.

Every industry using Wire Rope has ramifications that make it important to consider each Wire Rope installation as a separate and distinct application. Wickwire Spencer Steel Company will gladly send you information about the "Special" for your industry.

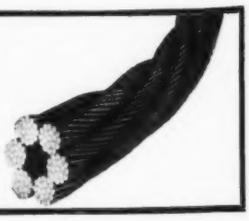
●

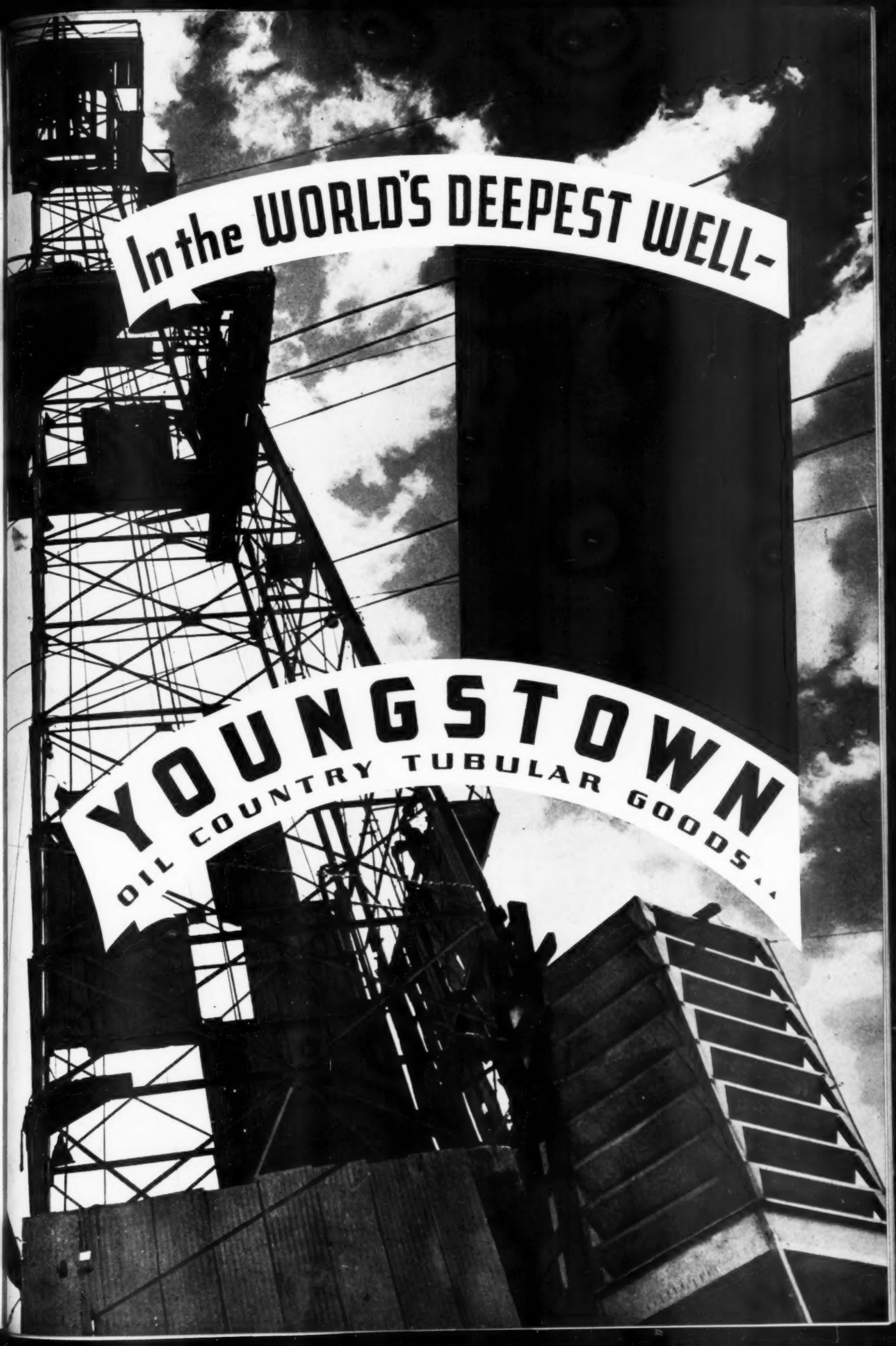
WICKWIRE SPENCER STEEL COMPANY, New York City, Buffalo, Chicago, Worcester; *Pacific Coast Headquarters:* San Francisco; *Warehouses:* Portland, Los Angeles, Seattle. *Export Sales Dept.,* New York City.

WIRE ROPE
by Wickwire Spencer

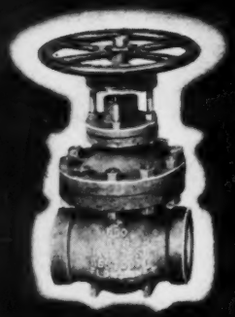
BOTH...STANDARD LAY AND WISSCOLAY PREFORMED.

Wickwire Spencer manufactures all sizes and types of Wire Rope in standard lays and preformed. Wisscolay preformed wire rope will often solve a wire rope application difficulty. Ask our engineers where and when it should be used. Send for a free WIRE ROPE BOOK. It will prove of great value.




In the WORLD'S DEEPEST WELL-
YOUNGSTOWN
OIL COUNTRY TUBULAR GOODS

CONTINENTAL



SEMI-STEEL FLOW LINE VALVE

Each year, each month sees changes in every industry. There is the continual search for something that will do a better job for less cost. We present for your approval a group of Westcott Valves that are making history in the oil and gas industry.

"Serving the Oil and Gas Industries"

THE CONTINENTAL SUPPLY COMPANY

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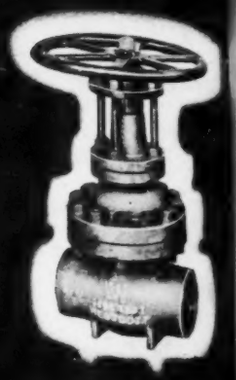
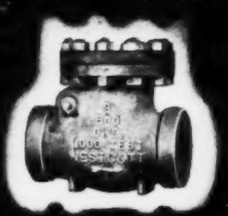


1500 LB. STEEL FLOW LINE VALVE

MEMBER
AMERICAN PETROLEUM
EQUIPMENT SUPPLIERS
ASSOCIATION

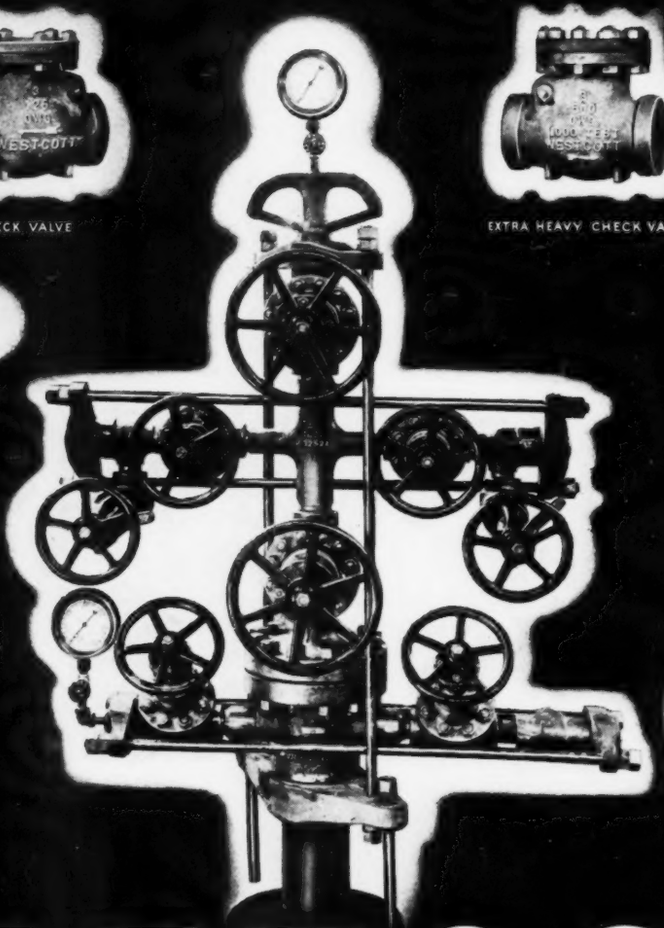
CHECK VALVE

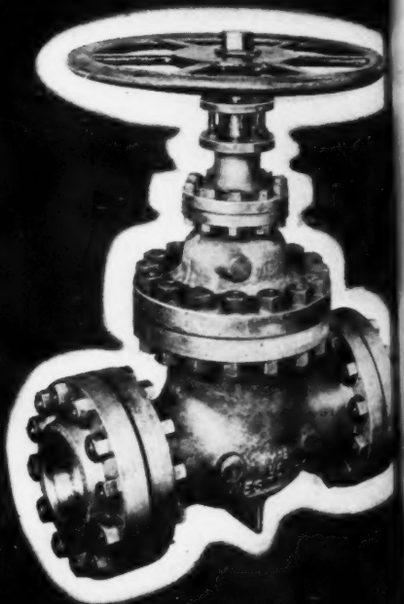


EXTRA HEAVY CHECK VALVE

1500 LB. SEMI-STEEL FLOW LINE VALV

7" STEEL FLOW LINE VALVE SCREW END





7" STEEL FLOW LINE VALVE FLANGE END

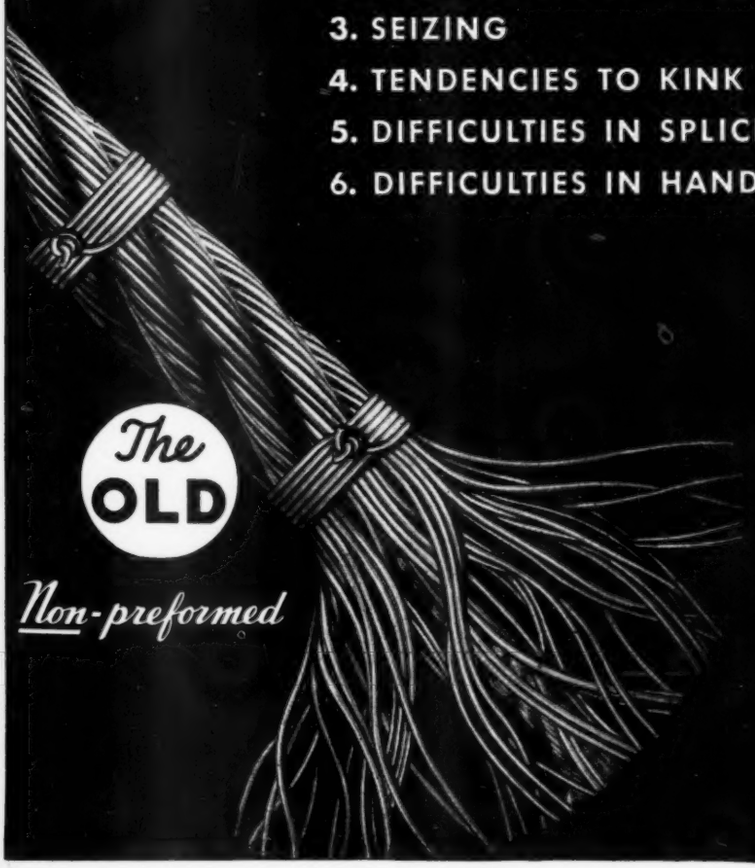
WESTCOTT
VALVES

Why WE MANUFACTURE AND RECOMMEND PREFORMED WIRE ROPE

For many uses Preformed Wire Rope gives increased service because the preforming process eliminates destructive internal stress which is inherent in every wire rope.

What is more, we recommend Preformed Wire Rope because it **eliminates** the following disadvantages:

1. UNBALANCED STRAND TENSION
2. LOW AND HIGH STRANDING
3. SEIZING
4. TENDENCIES TO KINK
5. DIFFICULTIES IN SPLICING
6. DIFFICULTIES IN HANDLING



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Hazard Wire Rope Co., Inc.
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Macwhyte Company
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Union Wire Rope Corp.
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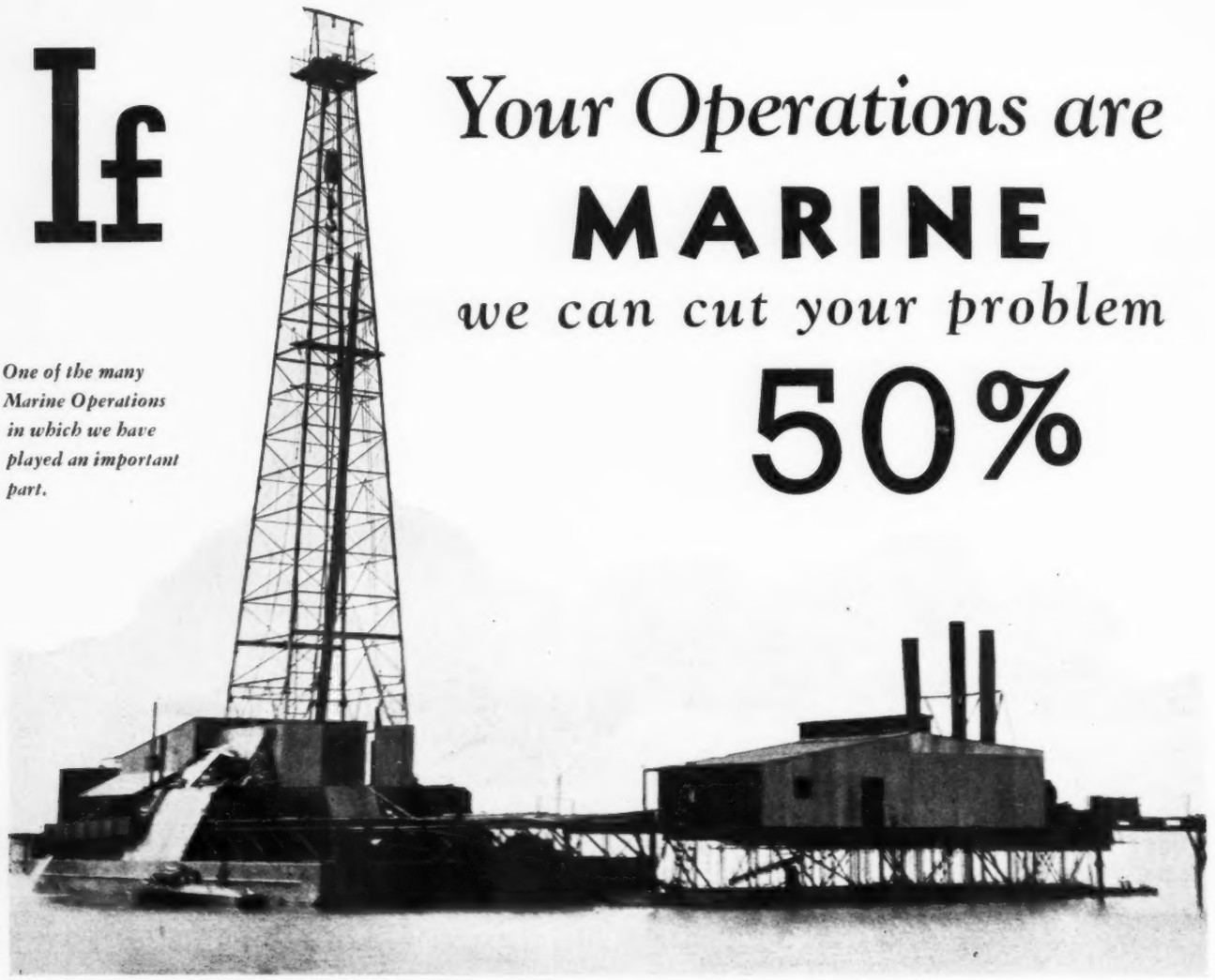
Wire Rope Mfg. & Equipment Co.

If Your Operations are MARINE we can cut your problem 50%

One of the many Marine Operations in which we have played an important part.



Drilling and Boiler Barge units above, of Texaco Type, on location in Lake Barre, Terrebone Parish, Louisiana—one of several such units operated by The Texas Company on its water operations in this area.

You can now float your entire drilling set-up to your water location, intact . . . open the sea-cocks and sink the barges . . . make them fast with only a fractional portion of piling necessary under the old method . . . and start drilling.

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WELL after WELL

WITH THE

SAME

PROTECTORS

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The unretouched photograph, above, shows Patterson-Ballagh Protectors that have been in service drilling several deep wells without replacement. Note their secure adhesion to the pipe. The lower photograph shows the same size of Protectors newly placed, ready for service. After long service Protectors should be replaced with new ones. Check over your drill pipe now equipped with Patterson-Ballagh Protectors. Renew them with the new extra long type—for longer service and greater durability.

● Be sure to specify Patterson-Ballagh Protectors—they are the original, genuine, all-rubber Protectors.

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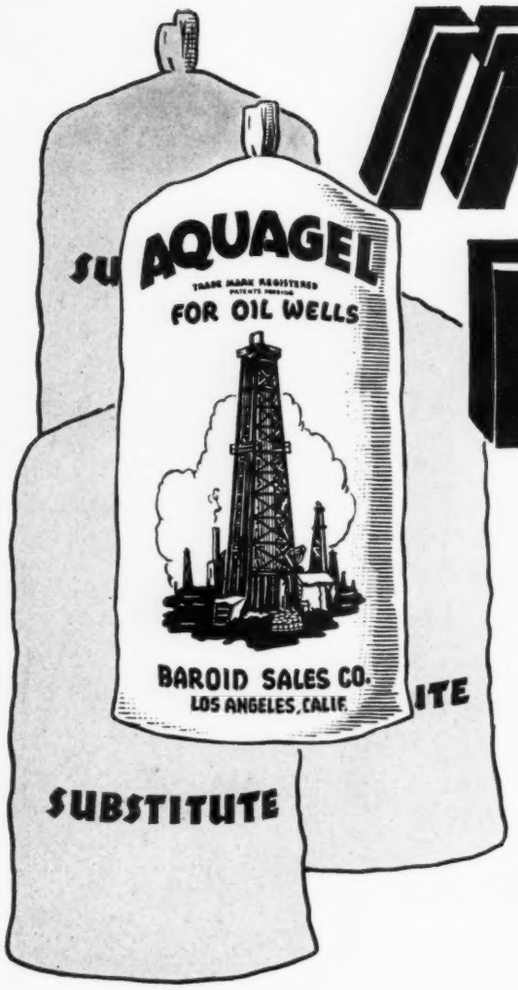

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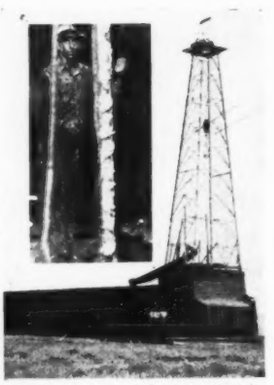
Denver Producing & Refining Co's. "Binger" well, controlled high pressures with Baroid



"Loading the bit" with Aquagel to eliminate cavings in Lario Oil & Gas Co's. "Neidenthal" in Western Kansas

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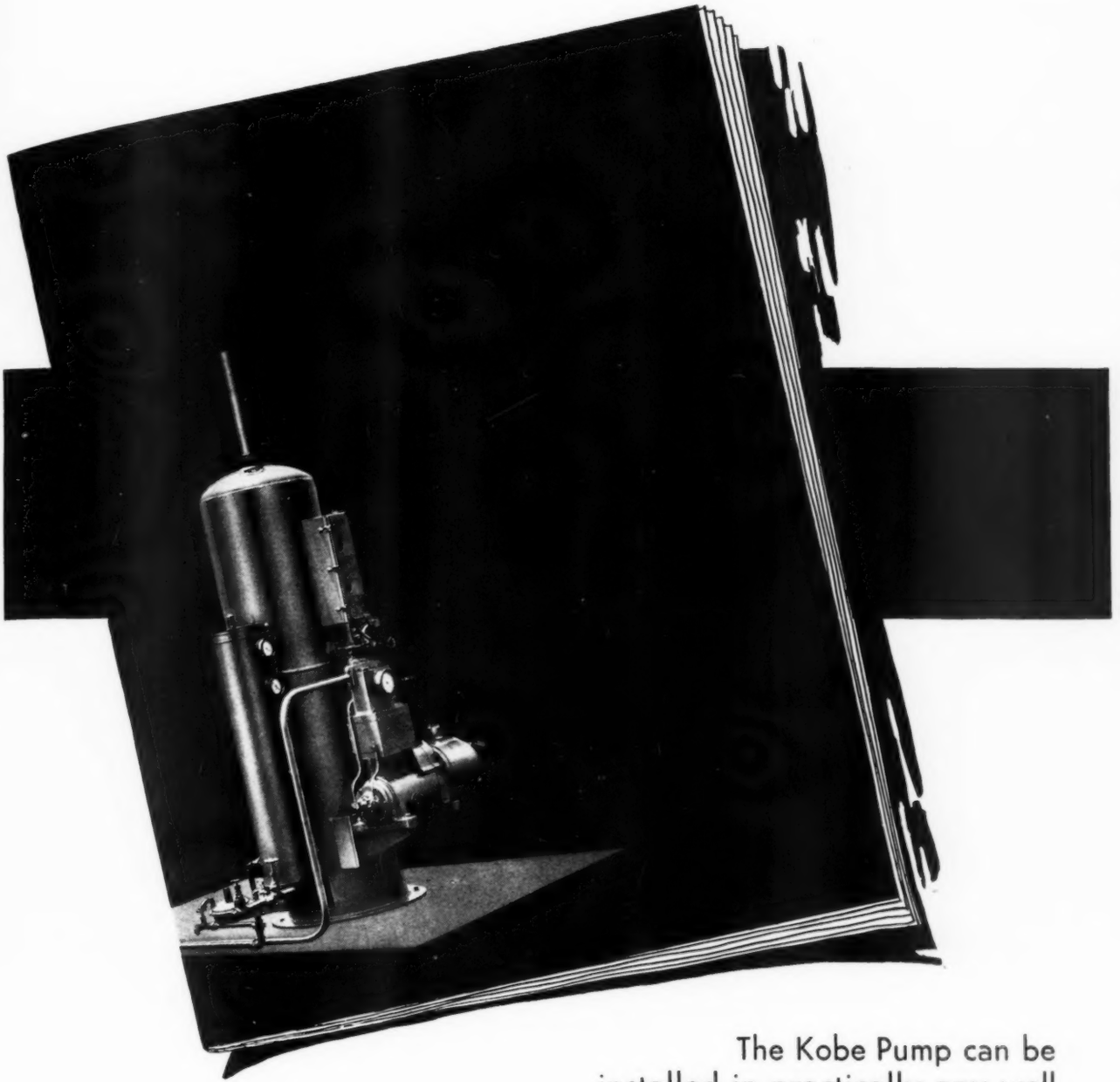

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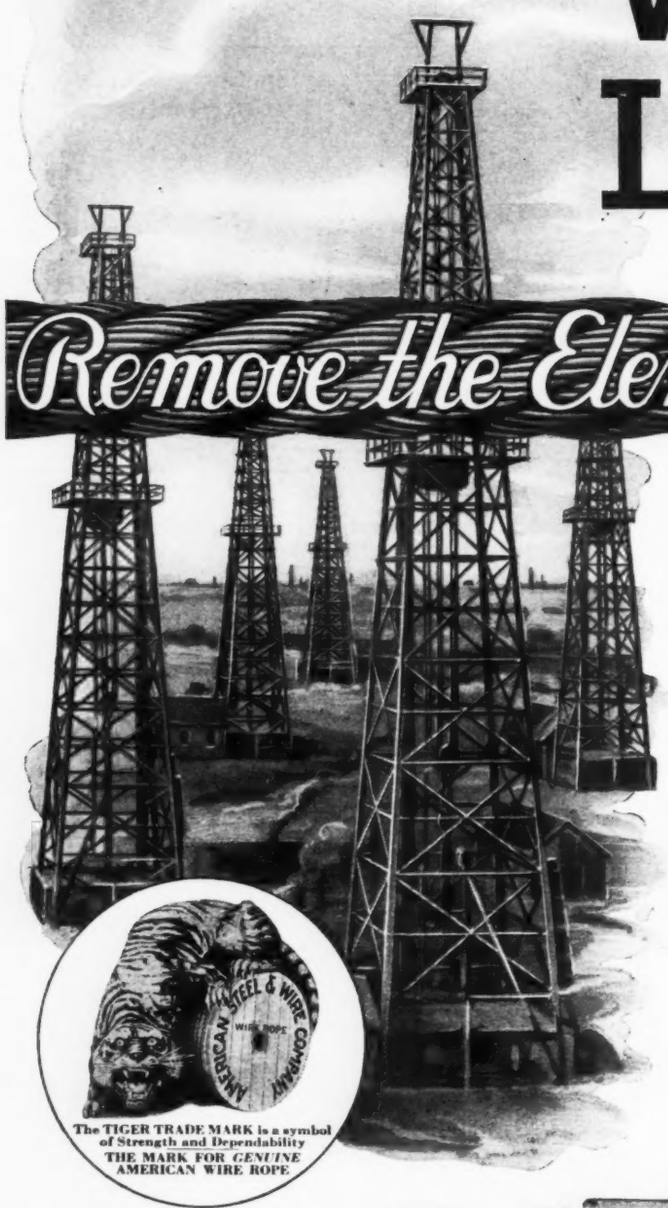
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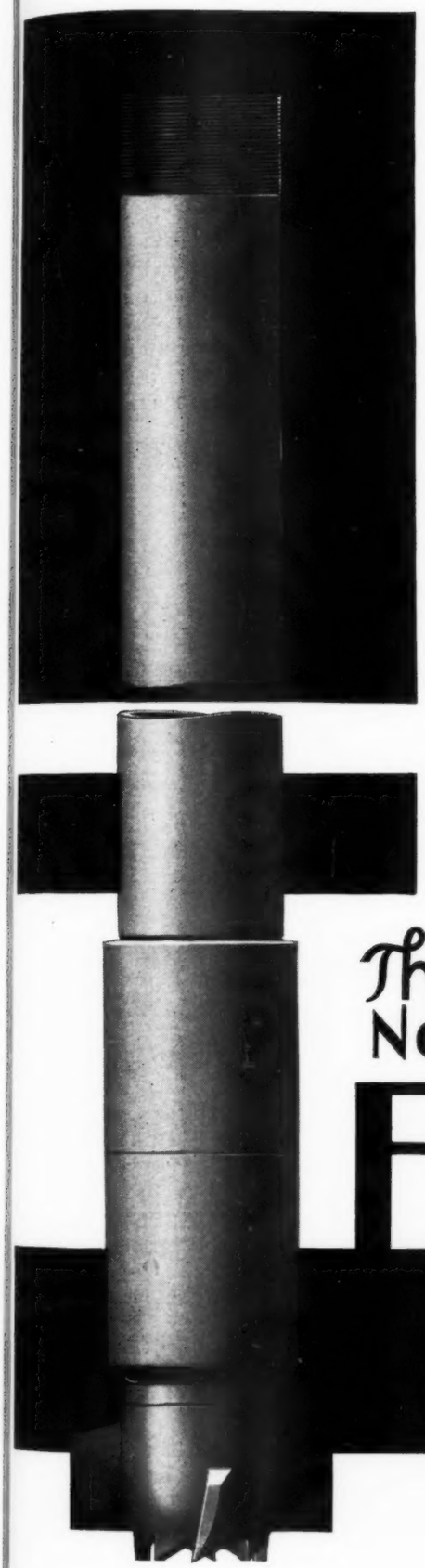
Wherever Cores Can Be Recovered The Elliott Will Recover Them



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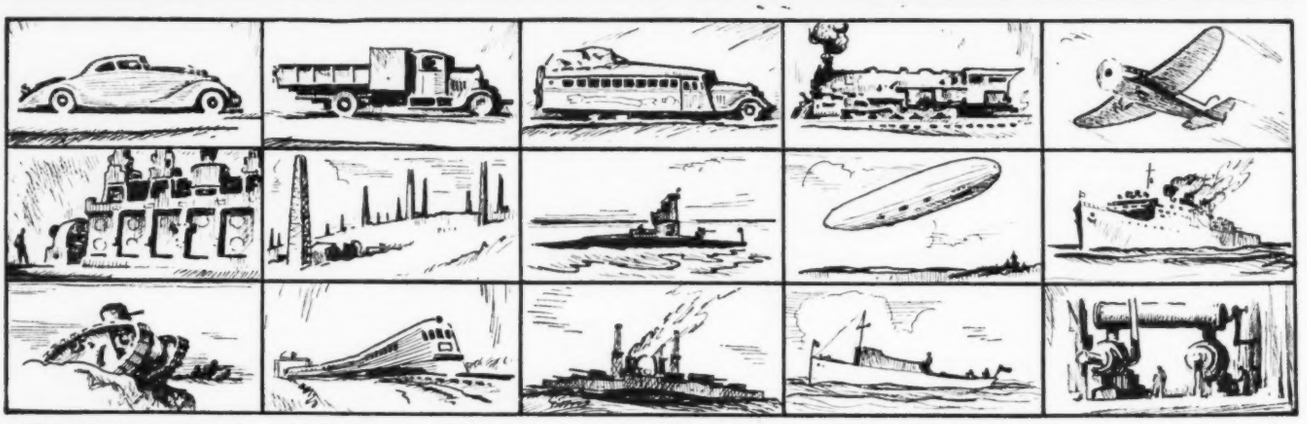

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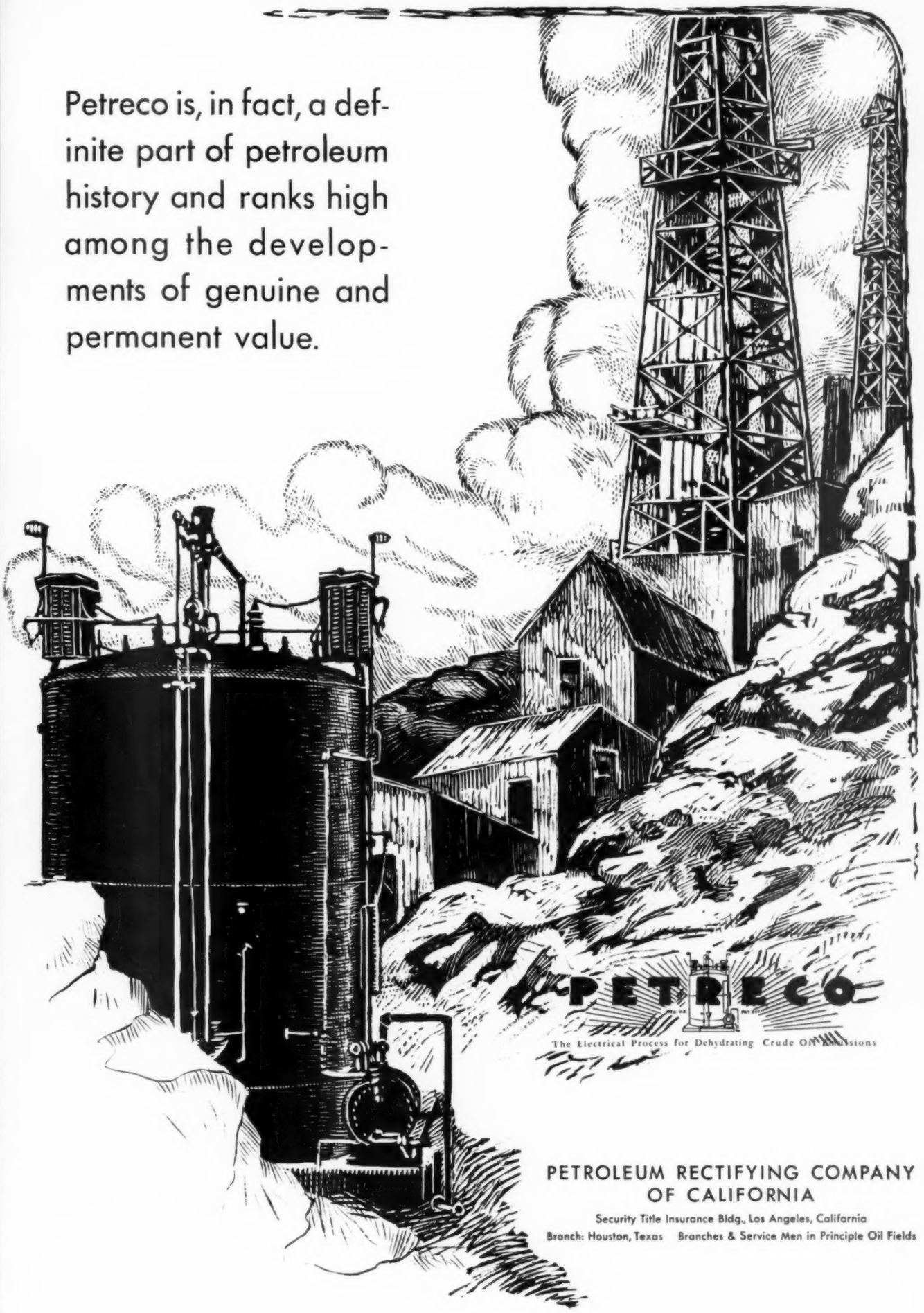

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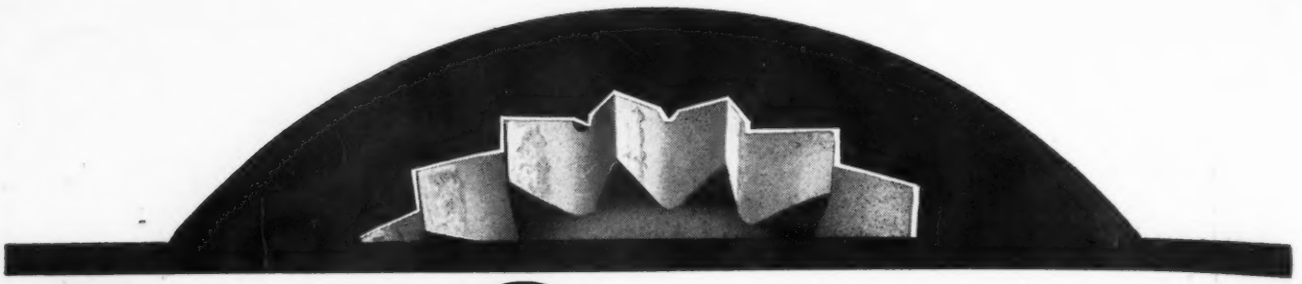

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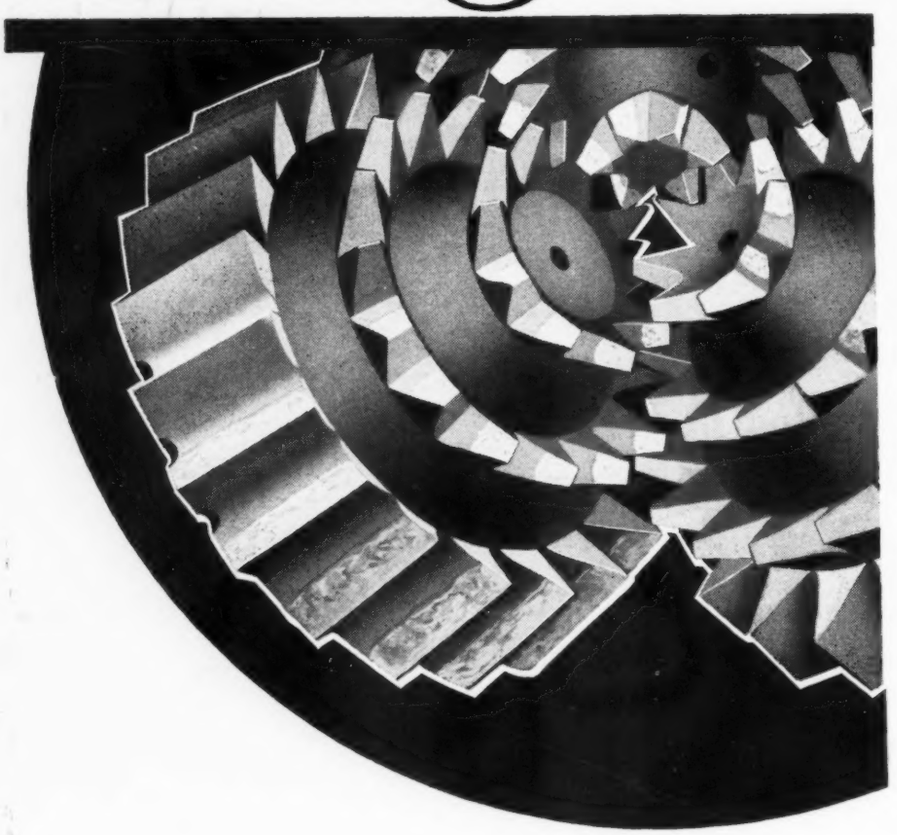

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